

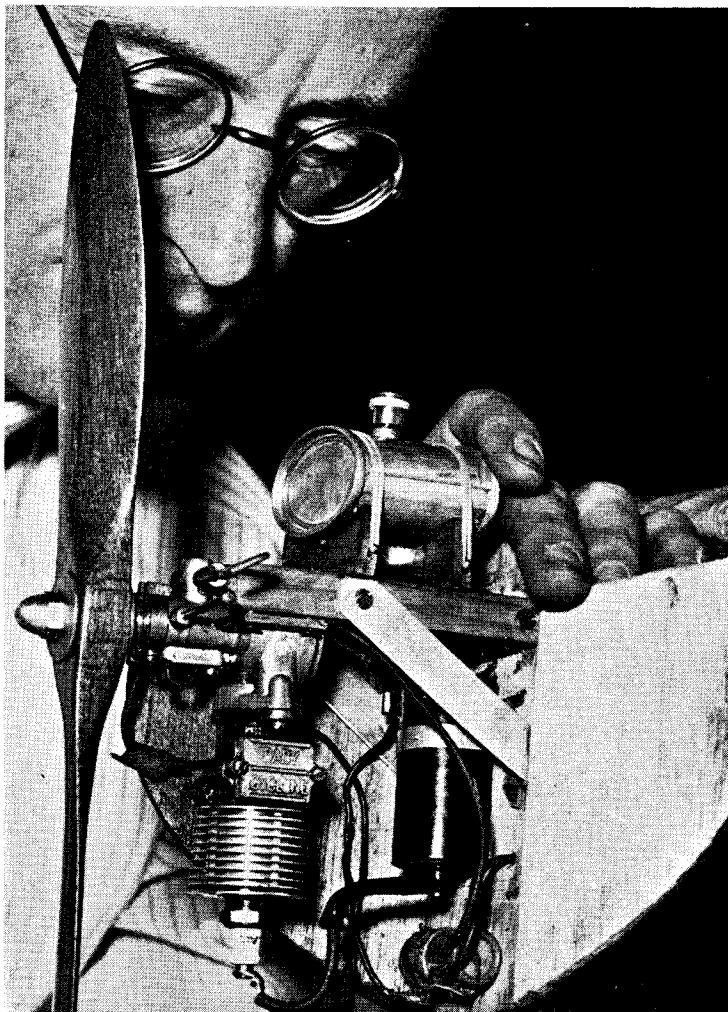
A Drilling Machine for the Home Workshop

# THE MODEL ENGINEER

Vol. 82 No. 2033 • THURS., APRIL 25, 1940 • SIXPENCE

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The petrol engine seen in this picture was built by a reader in Durban, South Africa. It is of 1.6 h.p. and is the power unit of a model aeroplane which has a wing-span of 5' 0", a weight of 3 lb. and a cruising speed of 20 m.p.h. The petrol tank holds sufficient fuel for a flight of 25 miles.

# THE MODEL ENGINEER

Vol. 82 No. 2033

April 25th, 1940

60 Kingsway, London, W.C.2

## Smoke Rings

### IMPORTANT TO EVERY READER

THE very serious position which has arisen in regard to the shortage of paper and paper-making material in this country makes economy in production of extreme importance to every publication. One step which we are obliged to take, in common with all other publishers, is to restrict the supply of copies of our journal to definite orders only. No newsagent will in future be able to carry a stock of copies for chance sales. In spite of this difficulty, the regular publication of THE MODEL ENGINEER will continue, but it is imperative that every reader wishing to secure his copy weekly should place a definite order with his bookstall or newsagent without delay.

\* \* \*

### What is a Gadget ?

THIS question is sometimes asked by readers of THE MODEL ENGINEER, and the answer is usually one that presents a little difficulty. The following reply to the question is taken from a recent issue of our esteemed contemporary *The Amateur Photographer*, and is one of the best we have yet seen: a gadget is a triumph of ingenuity over impecuniosity; an adaptation of the ordinary to the unusual; a transformation of the common or garden into the technical; a manifestation of the elasticity of the tanner's-worth. In short, a thing-a-ma-bob. And that is that !

\* \* \*

### The Feminine Locomotive

AT last somebody has diagnosed the reason for calling a locomotive "she." Mr. A. A. Gardiner, of the Canadian National Railways, said in a recent address at Montreal: "They wear jackets with yokes, pins, hangers, straps and stays. They have aprons, also a lap, and not only shoes, but pumps and hose. They surmount great obstacles, but sometimes jump the track at the slightest provocation."

### A Narrow-Gauge Line in India

A RECENT mail brought me a cheerful note from an Army reader in India, whose name and location official regulations prevent me from mentioning. He is a real MODEL ENGINEER enthusiast, however, as the following extract from his letter will demonstrate, and I send him cordial greetings from his fellow readers at home. He writes: "I think it is a grand thing that you are carrying on during the war, and I fully agree with the reasons you gave in your editorials. Everyone needs something to do which will take themselves away from the realities of present-day life, and I can think of no better way than that of following up our mutual hobby. It is not so bad for us out here, as life continues pretty well as usual, although our 'shops' have been on overtime for some months. We don't feel the strain during the cold weather, but it won't be so good when the temperature gets in the region of 110 in the shade. I was up on the frontier last week, and there is a peculiar little narrow-gauge railway which runs between Kohat and Thal. The distance is about 60 miles and the locomotives are large enough to run on the 4 ft. 8½ in. track, the result being that they seem as if they are going to topple over at any moment. I was thankful that I hadn't to travel by it. I remember travelling up to Kohat about 18 months ago by rail from here at night, and wondered why the journey of just over 100 miles took about seven hours. The next time I had to go there I travelled by day, and discovered that every time we arrived at a station the engine was borrowed for about 20 minutes to do some local shunting. It is rather a trying job endeavouring to get to sleep in the trains up here, as there is none of the smooth starting and stopping which is so noticeable with the long-distance trains at home. The drivers of all the trains except mail trains are Indians, and they seem to drive mainly on throttle and whistle. There is seldom a few minutes goes by when the rattling of the coaches is not disturbed by the watery screech of the whistle. The note is so wobbly that I think you would mistake it for an air-raid warning and duck for cover."

*Percival Marshall*

# The Altrincham Regatta

**Seven clubs participate in successful Event**

THE Altrincham model power boat club held its first war-time regatta on its new pond, Atlantic Street, Broadheath, on Easter Sunday, at which the favourable weather conditions contributed to a very successful meeting. In addition to representative entries by the home club, there were entries from the Bournville, Blackburn, Chesterfield, North Staffs., Rochdale, and Fleetwood clubs.

The first event to be run was the nomination race of 3 laps which was won by Mr. Williams's *Faro* of the Bournville Club with an error of only 1.1 secs. Incidentally, his speed of 41 m.p.h. was the fastest recorded during the day.

This was followed by the 15 c.c. event, also of 3 laps, which was won by Mr. Hayhurst's *Praps* of the Blackburn Club, at a speed of 35 m.p.h. in the first run. Mr. Innes of the home club came second with *Satellite III*, at a speed of 34.02 m.p.h., which was exactly the same as *Praps* on her second run.

It was noticed that Mr. Hayhurst was using an engine with vertical valves, as originally designed by Mr. Westbury, and described in THE MODEL ENGINEER, January 24th, 31st, February 7th and 14th, 1935.

An interesting entry in this event was by Mr. Coleman of the home club with his 24 in. hydroplane built to Mr. Westbury's design and published in THE MODEL ENGINEER last year. This boat was powered with a 7½ c.c. commercial engine and completed 3 laps in 37 seconds an average speed of 16½ miles per hour.

The 30 c.c. event of 6 laps which followed opened in a slight shower of rain, which was happily of short duration, and was not repeated. Mr. Williams again had the honour of securing first place at a speed of 39.3 m.p.h. Several 15 c.c. boats were also entered in this event, Mr. Hayhurst and Mr. Innes again doing well at 34.1 and 33.6 m.p.h. respectively. The



**Members of the Altrincham club preparing for the regatta.**

Ladies' Nomination Prize was awarded on the result of this race.

In the Steering Competition which followed, Mr. Buck of the North Staffs. Club easily gained first place with his boat *Cheerio*, scoring 8 points out of a possible 9.

Two very interesting entries in this event were Mr. Waterton's steam tug *Acklam Cross*, which will be remembered as the winner of the Spectator Cup at THE MODEL ENGINEER Exhibition of 1938, and Mr. Hayhurst's cabin cruiser powered with a 5 c.c. 4-stroke "Kinglet" engine.

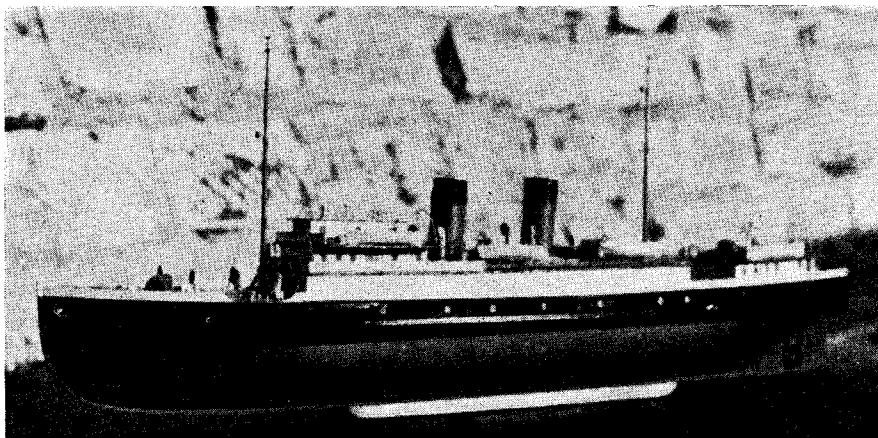
At the conclusion of a very pleasant afternoon's sport, prizes were presented by the President,

Councillor A. Vesey, J.P., who thanked our visitors for the way in which they had so ably supported the home club.

The club has been rather unfortunate in the matter of sailing water, but it is hoped that despite war time conditions we may again have the pleasure of meeting our old friends at the lakeside in the not too far distant future.



**Mr. Meageen (Altrincham) tuning up his two-stroke engined boat *Samuel*.**



## “Isle of Sark”

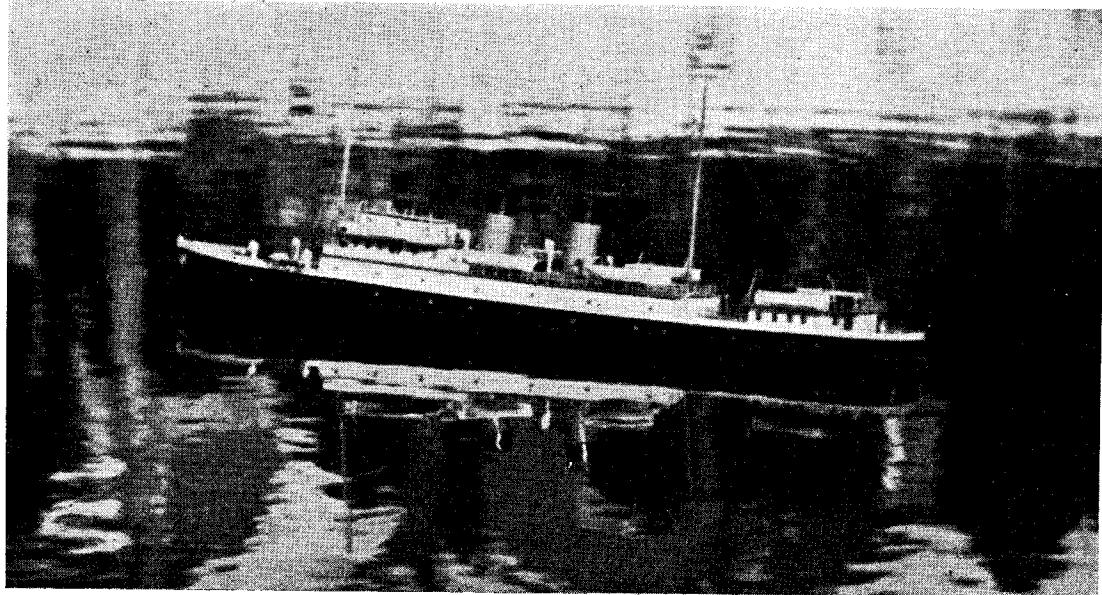
**Describing the alterations carried out to a model of the Southern Railway Company's steamship**

**By D. H. Pilcher**

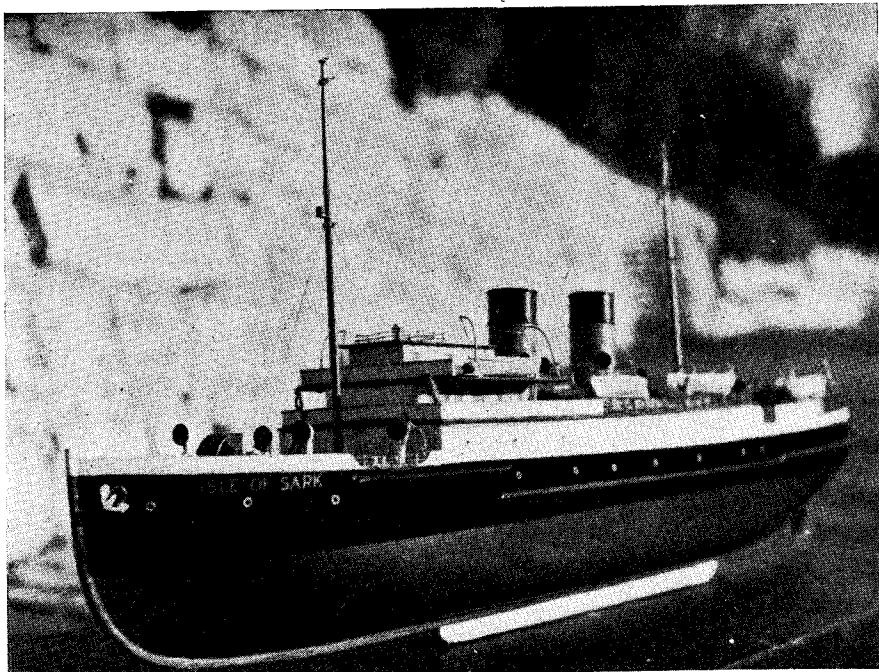
SOME time ago I purchased a model of the Southern Railway Company's steamship, *Isle of Sark*, which was made by a very well-known firm of model makers. Having travelled over to Jersey many times in this ship, it had a special interest to me, and the model happens to be a very good representation of the original.

When I came to try out the model on a pond I found that even in a very light wind it would not hold anything approaching a straight course; and, also, that the speed it attained was considerably less than I had expected.

I came to the conclusion that a more powerful motor was needed, and a small accumulator to deliver the heavier current required, also a better type of propeller. A small “Nautilus” type motor, taking 4 volts at 2 amps., was fitted, and also a small accumulator of 4 volt 10 amp. hour capacity. At the same time, the lead which had been placed inside the hull to bring the model floating on the required position for the water line was removed and a lead keel of rather greater weight was made and then fitted to the existing brass keel by means of screws. In this position,



The model of the *Isle of Sark* about to start off across the pond.



The model of the Southern Railway Co's. S.S. Isle of Sark.  
The added lead keel can be seen clearly in this photograph.

the weight acts at the end of a longer moment arm, thus producing a greater leverage to act against the force of the wind which is tending to turn the model over on its side. This principle is always put into practice in sailing yacht models where it is necessary to keep the whole thing as light as possible; the longer the moment arm the less the weight will need to be, hence the very deep keel used.

#### The Straight Course Problem

After these alterations had been made, the model was taken to the pond; and, though the results obtained were better than before, still the model would not hold a straight course. There happened to be other models of about the same type and fitted with similar power units being sailed on this occasion, and I found that they fared no better in this respect. The only one to be able to hold anything approaching a straight course even in a light breeze was a model of a yacht, about 4' long, driven by steam. This rather puzzled me, so I determined to investigate the matter more closely. On reducing the problem to mathematics the reason became perfectly clear. For the sake of those who may be up against the same problem, here is the answer.

#### The Answer

Supposing the model to be built to a scale of 1" to 10', that is, 1/120 of full-size; to remain in proportion the strength of wind and the size of ripples must be scaled down proportionately. This, however, is impossible, and a wind of even 10 miles an hour would correspond to a wind of  $10 \times 120$  miles an hour acting on the full-size vessel.

The maximum speed of the full-size vessel is about 25 miles an hour; scaled down this comes to about 1/5th of a mile an hour. A small electric motor will drive the model at about 4 miles an hour when there is no wind acting on the model. This is  $4/25$ ths of the top speed of the original. Scaled down, a wind of 80 miles an hour, which is the strongest the full-size vessel is likely to encounter, would be represented by a breeze of 12.8 miles an hour (on this new scale).

There are two forces acting on a model, one driving it forward on a straight course, the other, the wind, which is pushing it off its course.

#### The Parallelogram of Forces.

Applying a very well-known mechanical law, the

"parallelogram of forces," which states that if two forces acting at a point can be represented both in magnitude and direction by the adjacent sides of a parallelogram, then the resultant of these two forces is expressed by the diagonal of the parallelogram passing through that point, we obtain a very accurate idea of the result.

Supposing the force required to drive the model forward at 4 miles an hour is 0.91 lb., and with a wind of 15 miles an hour striking the model at right-angles, the force tending to push it off its course is 0.36 lb.; drawing the parallelogram of

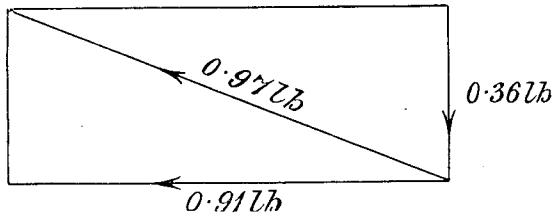


Diagram of forces mentioned by the author.

forces we obtain a result of a force of 0.97 lb. driving the model about 21 degrees off a straight course.

How to calculate the wind pressure, and the force required to drive the model forward at a given speed, and how to reckon the area of the rudder blade and the extra power required to make the model hold a straight course is a matter that, on account of space, must form the subject for a second article.

# “The Bat”

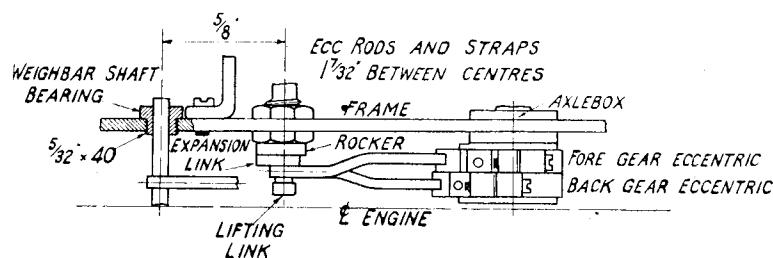
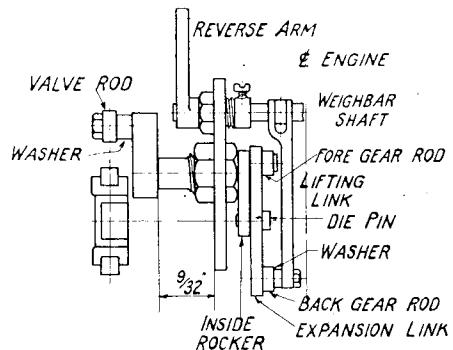
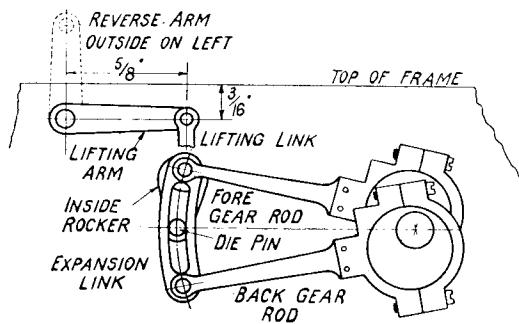
By “L.B.S.C.”

## Link Motion

SOME of the followers of these notes who are building “Bats” have forwarded more or less gentle reminders that the drawing of a link motion was promised; have I forgotten same, and, if not, what about it? Well, the trouble is just this. As I mentioned when describing the loose eccentric gear, I “visualised” a complete Stephenson link motion for the engine, but it was *as fitted to the engine*, and *not* as pencil lines on a piece of paper. Now when I am building a locomotive, I just go right ahead and copy the job as my mind’s eye sees it on the bench in front of me, which is easy enough; but when it comes to taking a very material steel rule, and trying to measure up my “ghost,” so that I can make drawings of it—well, you have probably all heard the song about a “dream walking,” but it has nothing at all on the job of catching a “spook” valve gear and setting it out in black and white! However, it was done, and here it is. My own “Bat” has not yet reached the valve-gear stage—too many other things have to be attended to in this business of earning a living!—otherwise I might have put up the link motion on her and made sketches from that.

The gear is arranged as simply as possible, and the parts are strong enough to stand up to all the battering it is likely to get in service. A similar

arrangement of links and eccentrics was fitted to two  $2\frac{1}{2}$  in. gauge engines, a 2-8-0 and an Atlantic, and both engines are still running after many years’ service, with the gears practically unworn. Though long ago I ceased using plain pins for die blocks on  $2\frac{1}{2}$  in. gauge, they are quite satisfactory in this small size. The die-pin takes the place of the eccentric-rod pin in the loose-eccentric gear; and a simple locomotive-type link, with the eccentric-rods connected at top and bottom of the slot, on the radius line, slides over the pin. The eccentric-rods have no forked ends, merely plain eyes, like those on the experimental “Purley Grange” recently described, and are connected to one side of the link by a headed pin at the top and a longer nutted pin at the bottom, the latter serving a double purpose, as the lifting-link is coupled to it. The links are lifted and lowered by a weighbar-shaft with horizontal arms plus the usual lifting-links, the upper ends of which are forked, to eliminate side movement and retain the expansion-links in position on the die pins. The gear may be notched up or reversed by a lever, or wheel and screw, as desired; if a lever is used, a notched quadrant and latch are not necessary if the lever is made to work fairly stiffly. A gauge “O” sector plate, trigger and latch would be too flimsy to stand up to any normal usage, whilst even a small child’s fingers would find it difficult to operate.

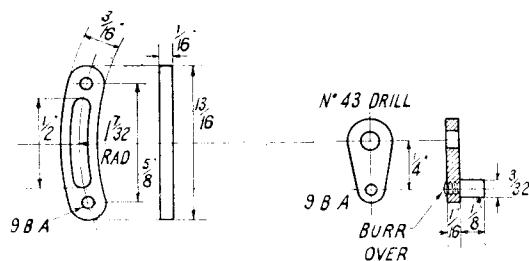


Elevations and plan of link-motion for the “Bat.”

### Construction—Rocking-Shaft and Arm

In place of the inner rocker-arm of the loose-eccentric gear, which is  $\frac{1}{8}$  in. in thickness and slotted, a crank-type arm is needed. This is made similar to the outer arm previously described, but is only  $1/16$  in. in thickness. The crank-pin may be plain, as shown, or headed if preferred; but if the latter, the head must be filed oval, so that it does not foul the eccentric-rod eyes when the link is at the extreme limits of travel. It must also not be burred over, or the links cannot be fitted to it. The arm is made a press fit on the shaft, same as before.

The head of the rocker-shaft bearing inside the frame must be reduced to  $1/16$  in. thickness to obtain the necessary clearances; and, whilst on this subject, a friend pointed out that I had cut things plenty fine enough on the outside rocker-arm, as his edition came too close to the guide bars to be pleasant, and he had filed a clearance. Well, that trouble is very easily overcome; and, in case anybody else is in the same boat, I have shown



**Expansion-link and rocker.**

the outside rocker in the end view of the complete gear, arranged for ample clearance. Simply turn  $1/16$  in. off the end of the bearing, reduce length of shaft to suit, put a pin  $1/16$  in. longer in the upper end of the arm, and a  $1/16$  in. bronze washer between valve-rod eye and the rocker arm, to keep the valve-rod parallel with frame. That is simple enough; it can be done with either loose-eccentric gear or link motion, and no filing of clearances will be necessary.

### Expansion-Links and Eccentric-Rods

If you can get hold of a piece of the steel known as "ground flat stock" as used for making gauges and other precision tools, make the links of that, as they can be hardened and tempered, and will last practically "for ever." If not, use a bit of bright mild-steel as left over from frames, and case-harden the links when finished. The outline and dimensions are given on sketch. It is not worth while to set up and machine these weeny components; whilst you are fooling around on soldering the bits of steel to a brass plate, and making an end-mill or slot-drill to cut the curved slots, a watchmaker's small file, plus a bit of

$3/32$  in. silver steel or 13 gauge spoke-wire, to use as a slot gauge, will do the trick. Drill a few  $5/64$  in. holes along the centre line of slot, run them into one with a rat-tail file, then carefully open out with the watchmaker's file until the  $3/32$  in. gauge runs up and down the slot without shake. Put a distinguishing mark on the links, so that you can tell "t'other from which," and then countersink slightly, the pinholes on the "frame side" of the links, before tapping them. If of cast steel, heat to redness and quench in clean water; polish up by rubbing on a sheet of fine emery-cloth, then lay them on a piece of sheet iron, and hold over a mild gas or spirit flame until they turn brown. Quench out quickly before the blue colour appears. If mild steel, heat to redness, dip in any good hardening powder (Kasenit, Ecosite, etc.), reheat until the yellow flame dies away, quench in clean cold water, and polish with fine emery-cloth.

The eccentric-sheaves are the same size as described for the loose eccentric gear, but have no stop pin, and are drilled  $3/32$  in. out of centre. A No. 53 hole is drilled through the thickest part, from the edge to the axle hole, and opened out to  $3/32$  in. for about  $3/32$  in. depth, the rest being tapped 9 B.A., and a pointed setscrew fitted.

The straps and rods are made the same as for the loose-eccentric gear, except that the rods are set over as shown in the plan view. Note—very important this—the length between centres of strap and eye must be  $1 \frac{7}{32}$  in. after bending. The eyes may be case-hardened if desired.

The fore-gear rod is attached to the upper end of the link by a 9 B.A. headed pin, similar to the pins shown in the drawing of the loose-eccentric gear. File the head off to a thickness of about  $1/64$  in. (see end view). The pin will not want to come out any more, unless it wears badly, and then it will be no good anyway, so it will not matter about wrecking the remains of the head with pliers. The lower pin is made from a bit of 15 gauge spoke-wire,  $9/32$  in. long overall, and screwed both ends. The eccentric-rod eye is just slipped over it, no separate fixing being needed. Rivet the threads slightly into the countersinks in the links.

Eccentrics and links can now be erected; take the straps apart, put them over the sheaves, with the slot in the link over the die-pin, and screw the halves of the straps together again. The wheels should turn freely, and the link should be capable of running up and down the die-pin without binding or sticking anywhere. The sheaves should be set temporarily opposite to one another, by eye.

### Weighbar Shaft and Lifting Links

Cut a  $1\frac{1}{4}$  in. length of  $3/32$  in. silver steel or 13 gauge spoke-wire for the shaft. The two lifting arms are filed up from 16 gauge steel, the shape being shown in the side view of the motion, so that no separate sketch is needed. The larger end is drilled No. 43 and the smaller No. 48, the distance between centres being  $\frac{5}{8}$  in. Drive one on

the shaft, so that its centre line is  $11/16$  in. from one end, and the other one  $\frac{1}{4}$  in. nearer the end (see sketch). The vertical line at the end of the  $9/16$  in. arrow on the sketch indicates the centre line of the engine, and the arms are located  $\frac{1}{8}$  in. either side of it. Have the two arms dead in line; poke a bit of 15 gauge wire through the holes in the small ends, and then silver-solder the arms to the shaft. Clean and polish.

The reverse-arm is made similarly, but is only  $\frac{1}{2}$  in. between centres. Silver-solder a little boss made from a scrap of  $3/16$  in. steel rod to the larger end; this should be drilled No. 43.

The lifting-links are made from  $\frac{1}{8}$  in. square steel. File or mill away one side as shown, to leave an offset forked head. It is a good wheeze to slot the ends of the rods first, by clamping a length of rod (enough for two links) under the lathe tool holder, running it up to a cutter on a spindle in the three-jaw, then turning it end for end and repeating operation. The lower ends of the links are rounded off and drilled No. 48.

The bearings for the reversing-shaft are two little screwed bushes as shown in plan sketch; these are turned up from  $3/16$  in. hexagon rod, drilled No. 41, and screwed  $5/32$  in. by 40.

#### How to Erect the Shaft

First of all, mark off a place on each side of frame, for the bearing bushes. This is located  $3/16$  in. from the top of the frame, and  $\frac{5}{8}$  in. ahead of the rocker-spindle bearing, which lands it just clear of the guide yoke flanges as shown in plan sketch. Drill the holes No. 30 and tap them  $5/32$  in. by 40. Now take the weighshaft, and enter the longer end through the left-hand hole from the inside of the frame; do not forget to put a small setscrewed collar on it, to prevent side movement after assembly. By a little judicious manipulation, the shaft can then be got into position, with the other end through the opposite tapped hole, after which the bushes can be screwed in from outside the frame. Next squeeze on the reverse-arm, at right-angles to the lifting-arms; then adjust the collar so that the lifting-arms are centrally between the frames.

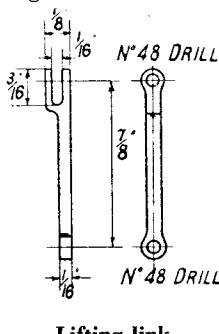
Put a bronze washer on the bottom pin in the expansion-link, then the lifting-link, and finally a nut (see sketch). Whilst doing this job, you will probably wish the locomotive were 4 ft.  $8\frac{1}{2}$  in. gauge instead of  $1\frac{1}{4}$  in., and mentally consign it, along with Uncle Adolf, to some unknown destination. However, patience and perseverance wins, if a sufficiency of both commodities is available; the lifting-arms can then be inserted in the forks, and a long single bolt, made from 15 gauge spoke-wire, nutted at both ends, put

through both of them. If everything has been fitted O.K., the gear should reverse easily, by pushing the reverse-arm back and forth, with the links in any position, either vertical or fully inclined.

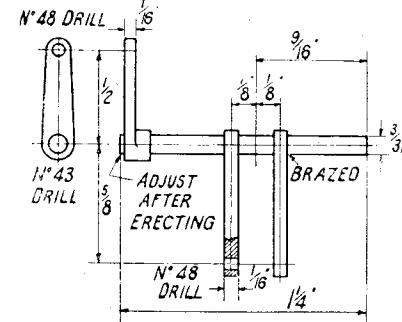
#### How to Set the Valves

This is just as easy as with the loose-eccentric gear. Set the reverse-arm back so that the top of the expansion-link slot rests on the die-pin, then turn the wheels, and watch the valve, with the steamchest off and a temporary guide rigged up, as previously described. If the ports do not uncover an equal amount at each end, follow the procedure described for getting even port openings with loose eccentrics. Next take off the straps, and adjust the setscrews in the sheaves, so that they can just be turned on the axle; replace straps. Put the main crank on front dead centre; turn the fore-gear eccentric (next the axle box) in a forward direction until the front steam port just cracks. Then leave the eccentric, and turn the wheels. If the back port cracks, as the crank passes back dead centre, the setting is correct for forward gear.

To set the valve for back gear, push the reverse-arm so that the bottom of the expansion-link slot is against the die-pin, and fix it temporarily. Put the main crank on front dead centre again, and turn the back-gear eccentric in a backward direction until the port cracks. Repeat "second half" as above. Take off straps with great care, to avoid



Lifting-link.



Reverse or weighbar-shaft.

upsetting adjustment of the sheaves or tumblers; tighten setscrews in the latter, and replace straps. The steamchests can then be put on, the joints made, and the "works" tested with a tyre-pump as described for the loose-eccentric motion. In full gear, that is with the die-pin at the extreme ends of the link slots, the wheels should spin freely with a sharp crackly exhaust and no sign of hesitation; they should continue to turn, though with a quieter exhaust, with the die-pin almost in the middle of the slot.

No separate details are needed for the cab-lever. In fact, it might be dispensed with, and a knob fitted to the end of the reach rod, the latter passing through a bearing attached to the side of cab, when this is fitted. A screw reverser can be made by copying that described for "Purley Grange," "Olympiade," etc., to half-size. Watchworks ugh !

# Railway Practice

By Chas. S. Lake, M.I.Mech.E., M.I.Loco.E.

## Gearboxes and Locomotives

Whilst by no means condemning the suggestion that a suitable form of gearbox might not be adapted to locomotive requirements, the writer would remind a Southampton correspondent that for main-line as apart from industrial locomotives, railcars, etc., the principle of steam expansion is simpler and, within limits, equally effective as a means of varying and controlling the speed and power output of locomotives. What the locomotive designer has constantly to keep in mind is not only what such additions may entail in respect of first cost and complication of detail but also the question of maintenance and the preference, for the most excellent reasons, of a purely direct drive, relying on the expansive qualities of steam and the wider range afforded by increased boiler pressure, which is very pronounced. The tractive force is directly related to the steam pressure and influenced thereby, and any arrangement of mechanical gearing to assist the engine at starting or climbing heavy grades is regarded as unnecessary except in the case of boosters, Diesel locomotives and in a few cases, perhaps, of industrial steam locomotives. Designs of an ingenious character have been "got out" from time to time in which a high-speed vertical steam engine imparting its power through

gearing takes the place of the ordinary reciprocating cylinders, but such have not as yet been adopted for locomotives employed for working passenger and freight trains under what may be termed normal conditions on main-line railways.

## New Diesels for the L.M.S.R.

The L.M.S. Railway have recently placed in service in some of their large freight-marshalling yards 20 new six-coupled Diesel locomotives of the type illustrated herewith. The mechanical portions were constructed at the company's works at Derby, and the engines and transmission by the English Electric Co. In the design of these locomotives a single traction motor is employed with geared jackshaft and rod-drive and a method of control enabling speeds of 1 m.p.h. or less to be maintained evenly on "humps"—the inclined sections over which the wagons are pushed to allow of their being sorted by gravity in the concentration yard beyond.

The Diesel unit has six cylinders designed for a maximum output of 350 b.h.p. at 685 r.p.m., to which fuel is delivered by a C.A.V.-Bosch pump. A spiral tube radiator, located on the front of the bonnet, is used for cooling the circulating water and engine lubricating oil. The main fuel tank has



One of the new Diesel shunting locomotives, L.M.S. Railway.

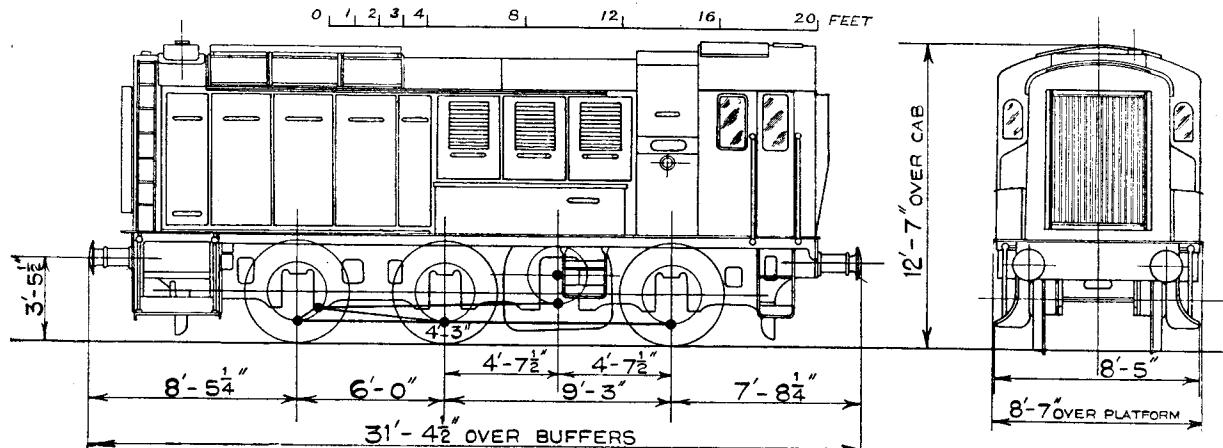


Diagram of 350-h.p. Diesel-electric shunting locomotive, L.M.S.R.

a capacity of 586 gallons, and there is, in addition, a service tank which holds 75 gallons. A 250-kW d.c. generator is directly coupled to the main engine, and the two are supported as one unit on three pedestals with rubber pads between the feet and the locomotive frame.

The maximum tractive effort is 35,000 lb. and the locomotive weighs 55 tons 5 cwt.; the maximum axle load is 18.9 tons and the top speed 20 m.p.h. The equipment includes Westinghouse brakes with self-lapping driver's valve, and air-sanding gear is fitted. The wheels are 4 ft. 3 in. diameter, wheelbase 15 ft. 3 in. and overall length 31 ft. 4 1/2 in. Wide steps for the use of shunters in flat marshalling yards are provided, and there are vertical sockets for the shunting poles.

#### "Effective" Heating Surface

Correspondents frequently ask for information on subjects associated with locomotive boilers, and many of the enquiries are centred in the important subject of heating-surface disposition. This matter has been dealt with by the writer on previous occasions, but it is still a common experience to receive letters asking that the topic shall receive attention in these columns. Two communications recently to hand refer to the term "effective" as applied to heating surfaces, and in one case the writer is asked to explain the relative values of "firebox and tubular heating surfaces."

The number of MODEL ENGINEER readers who have an especial interest in locomotives is doubtless constantly on the increase, and some at least have presumably not read what has appeared at various times concerning this aspect of locomotive design and construction.

There is a great deal to be said about the locomotive boiler as a steam generator, and any investigation of the kind must largely be based on the question of heating surface. The firebox, of course, ranks as the primary source of heat supply, and the efficiency of the boiler as a whole depends in great measure upon its design and pro-

portions including the grate; for it is on the effective combustion of the fuel that the maintenance of a suitable head of steam at the required pressure depends. This does not alter the fact that unless the tubes are correctly proportioned and spaced the successful operation of the boiler will suffer. The tubes naturally have the most value as heat distributors in the neighbourhood of the firebox, and undue length is a thing to be avoided. It is for this reason that the inclusion of a combustion chamber is becoming more common, and also that its length shows a tendency to increase. If, however, matters were carried too far in this respect, the gain might in some respects be converted into a loss of heat values. The combustion chamber forms a prolongation of the interior firebox, and within it the gases coming from the firebox co-mingle and pass on through the tubes in what may be termed a cleaner and more potential condition for imparting heat to the tubes and, from them, to the water by which they are surrounded.

Then a good deal depends on the size and design of the superheater, for it is by virtue of its action that the character of the steam supplied to the cylinders is improved by ridding it of moisture and liability to condense, thus impeding to some extent the free movement of the pistons and reducing cylinder output. Highly superheated steam at a high pressure is very effective in locomotive operation; a little goes further, and this is reflected in fuel economy and other benefits.

#### New Express Locomotives for a British Railway

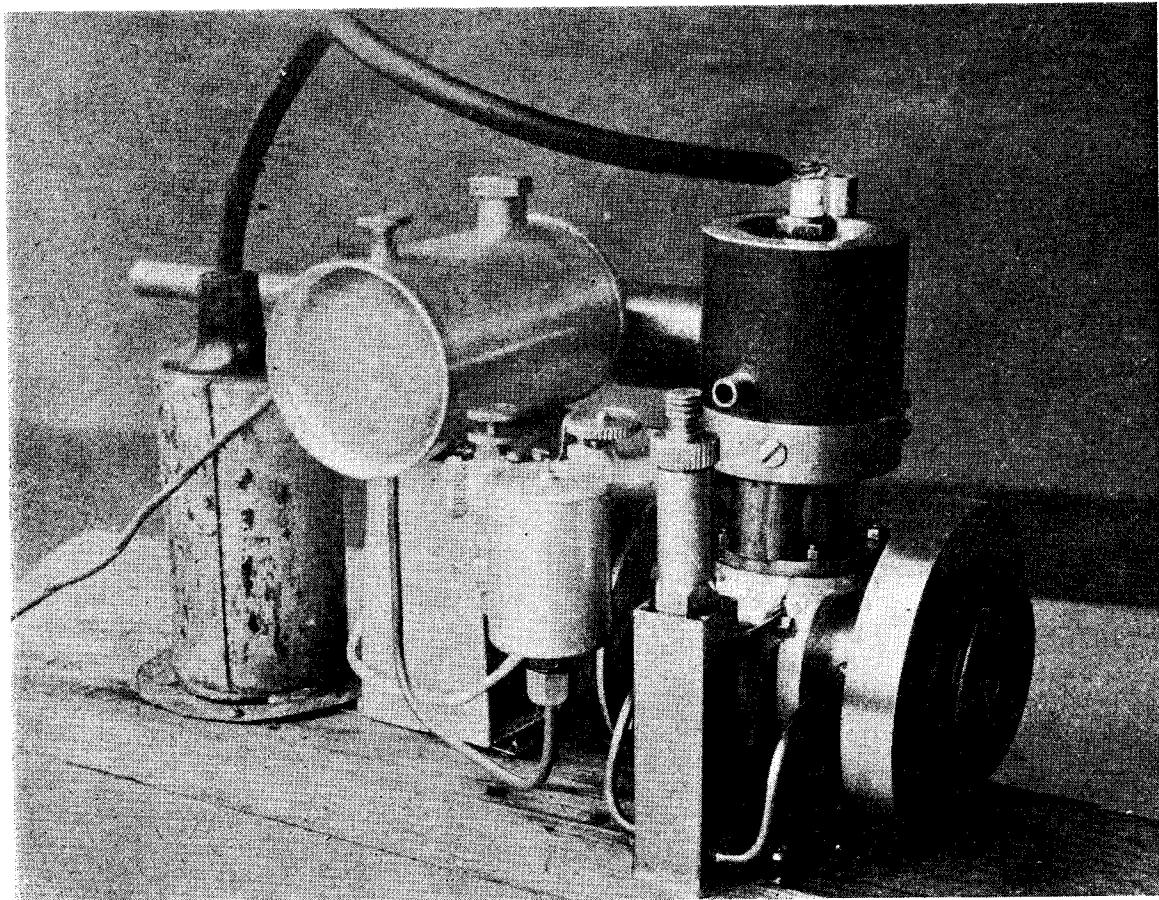
The writer is not yet permitted to refer in any sort of detail to the new engines now being built by one of the four group railways in this country, but, in answer to enquiries from readers, who will themselves appreciate which railway is concerned, it may be stated that the locomotives will be respectively of the 4-6-2 express passenger and 2-6-2 mixed traffic classes, neither of which has previously been used on this railway.

# An Experimental 15 c.c. Two-Stroke Engine

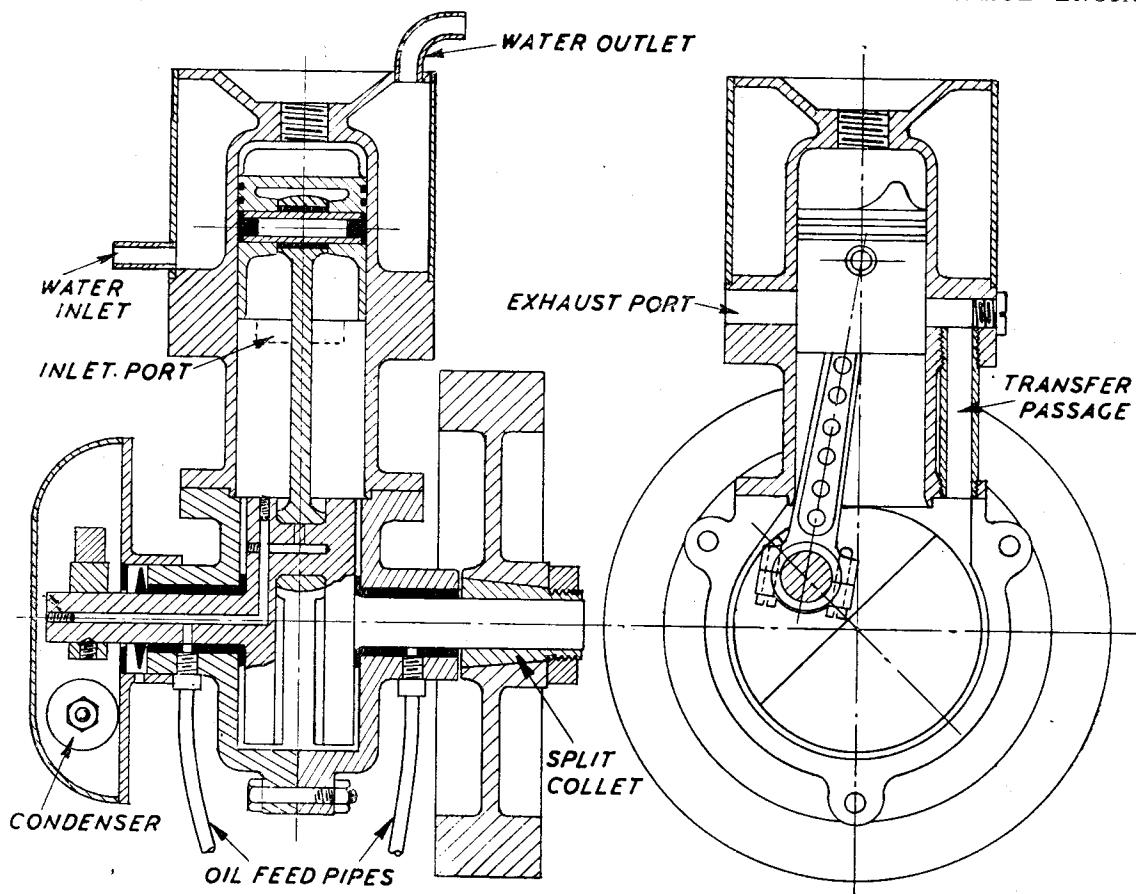
By S. Holmes

THIS engine is a first attempt at model petrol-engine design, and is based on data obtained in the past from THE MODEL ENGINEER. It is 25 mm. bore by 30 mm. stroke, which works out at approximately 14.7 c.c. capacity. The castings for the crankcase, carburettor, etc., were made at home in plaster of paris moulds, the material being old motor-car pistons, melted down in an old cocoa tin on a gas-ring, assisted by a Bunsen burner. Some experiment was found necessary to obtain really successful castings in this way, and a little trouble was experienced at first, owing to moulds not being thoroughly dry. This resulted in violent spluttering and bubbling when the metal was poured into the mould, but the fault was entirely cured by thoroughly heating the mould for some hours.

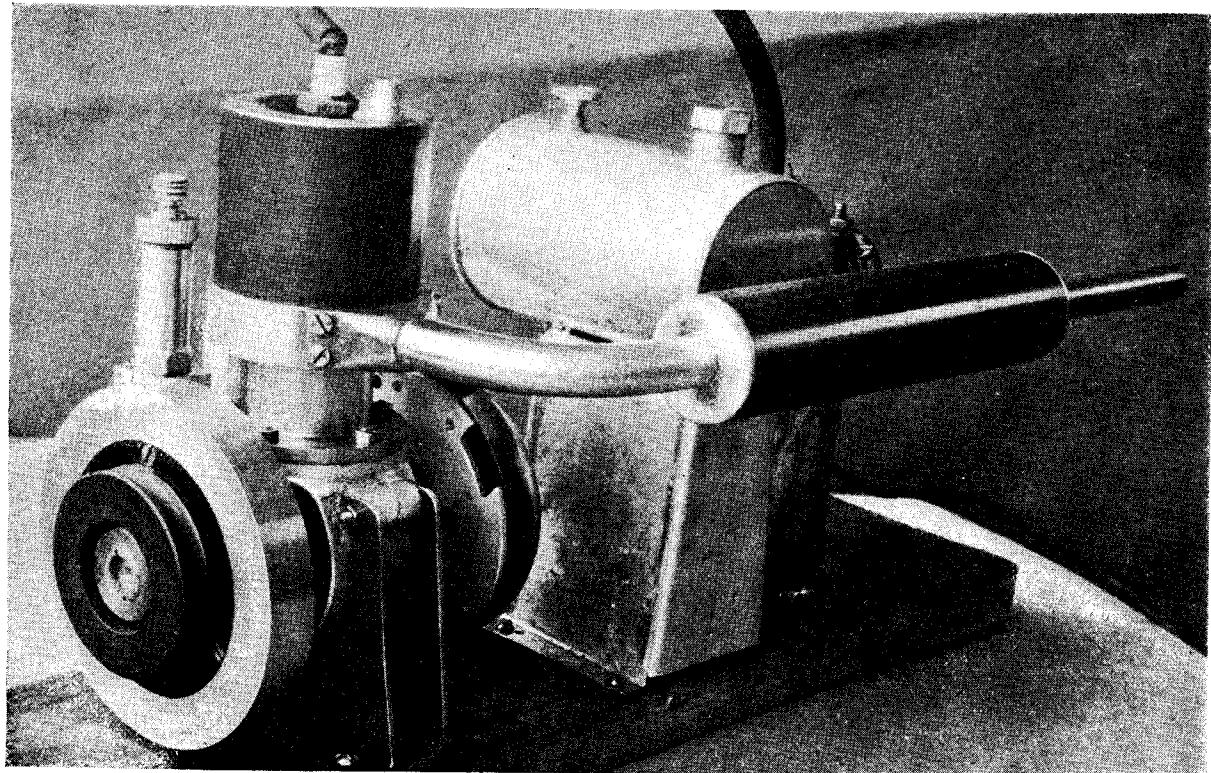
The cylinder is turned from centrifugal cast-iron cored rod, including the base flange, a wide belt for the ports, and a dished flange at the head. Over this the copper tube which forms the water jacket was pressed, locating against a spigot turned on the port belt, and making a watertight joint without any supplementary means of securing or packing. The transfer passage is formed by two thin-walled tubes, screwed their entire length and inserted from the underside of the base flange into the port belt. To conceal the rather unsightly screwed portions in the space between the base flange and the port belt, a thin casing made from a piece of tubing, split and opened out, is pressed over the two tubes. Both the transfer and exhaust ports are drilled diametrically through the port belt, the former being tapped out and plugged



The 15 c.c. engine set up for testing, showing Atom type "R" carburettor and oil service hand pump.



Sectional side and end elevations of engine, two-thirds full size.



Exhaust side view of engine, showing Burgess type silencer.

by short screws at the outer end. The piston is cast in aluminium and is fitted with two rings.

As originally constructed, the engine had a built-up crankshaft consisting of two mild-steel journals with flanges to form the webs, and a silver-steel crankpin clamped into the latter. This proved to be lacking in rigidity, and the crankpin became grooved badly after about a couple of hours' running. A new crankshaft was therefore made from solid three per cent. nickel steel, and has been entirely satisfactory. It runs in two long phosphor bronze main bushes, and the connecting-rod is made from solid phosphor bronze, with split big-end bearing. The flywheel is made of steel, and is secured to the shaft by means of a split collet, which fits the internal taper of the hub, and is drawn up to grip both the latter and the parallel shaft by an external nut.

A suction carburettor was at first fitted to the engine, and a simple form of contact breaker; the maximum speed thus obtained was about 4,000 r.p.m. This was thought capable of improvement, so that at the same time that the new crankshaft was fitted, a new contact breaker and carburettor

were also made. The former is exactly the same pattern as fitted to a motor-car, and is covered by a bell-shaped casing which effectively protects it from oil and dust. To prevent oil creeping into the casing from the bearing, an oil thrower was fitted to the shaft, with a drain hole immediately below it; this has proved most effective. Lubrication was also considerably improved by fitting oil-service pipes to both main bearings, and drilling the shaft to provide a direct feed to the big-end bearing.

The carburettor is made from the drawings of the Atom Type "R," published by Mr. Westbury in THE MODEL ENGINEER some months ago. It is a great improvement on the original type fitted, and provides excellent control from a tick-over to flat out. The maximum speed is now 6,500 r.p.m., and it is expected that much more speed will be found yet.

Every moment spent in building and running the engine has been most interesting and instructive, and I can fully endorse Mr. Westbury's recently expressed opinions about the fascination which model petrol-engines hold for their devotees.

## For the Bookshelf

**Calvert's Mechanics' Year Book.** (Sherratt & Hughes, the Saint Ann's Press, Timperley, Cheshire.)

What might well be described as a machine shop encyclopedia is the remarkable collection of illustrated operations, tools, and gadgets used on the bench and in all kinds of operations in the machine shop which are contained in this book, price 6d. (8d. post free).

An informative article on sheet metal working is one of the recent additions, and there are many other new features. Matters pertaining to screw-cutting and turning as in all other departments have been placed in appropriate sections, and the new arrangement facilitates easy reference. The section on steam has been rearranged to greater advantage, and the usual tables and calculations are features which have wisely been retained.

The illustrations are profuse and assist the mechanic to a greater understanding of the text. At such a modest price it can readily be understood why the orders reach over 50,000 copies.

**Brazing : Principles, Materials and Methods.** (London: Emmott & Co. Ltd.)

This is the latest addition to the "Mechanical World" series of shilling monographs, and deals very fully with the subject of brazing. Some useful theoretical matter is included as an aid to a better appreciation of the processes involved;

otherwise the booklet is essentially practical. A number of interesting tables and some excellent diagrams accompany the text, and enhance the value of the contents. Combined with Percival Marshall & Co.'s practical handbook "Soldering, Brazing and the Joining of Metals," the whole field of this important workshop process is fully covered.

**Elements of Automobile Engineering.** By Maurice Platt (London: Sir Isaac Pitman & Sons Ltd.). Price 5/-, postage 4d.

The modern motor car has now arrived at a stage of development in which it may be classed as an exact science, and the principles upon which its design is based are capable of explanation in terms which are fully intelligible to the engineering student. This book is intended to form an introduction to automobile engineering, and while strictly practical in its treatment of the subject, deals fully with the underlying principles of the various parts of motor vehicles, and their functions.

Car types, prices, weights and sizes are discussed, structural factors and road performance also being dealt with. An analysis of the various parts of the car follows, including chapters on the power unit, transmission system, suspension and steering, front and rear axles, braking systems, etc. The book contains 100 illustrations in line and half-tone.

# A Sensitive Drilling Machine

**Describing how a useful item for the workshop was constructed as the result of an urge to "make something"**

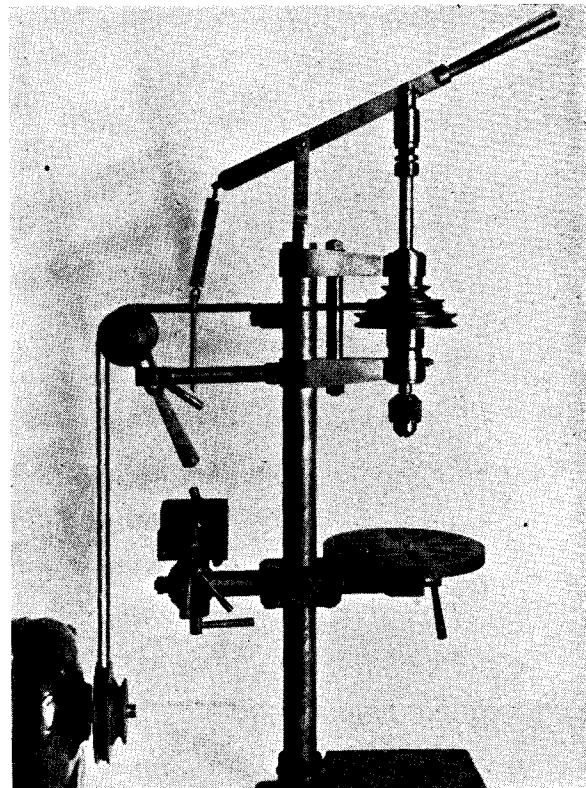
By W. L. Rowson

THE drilling machine about to be described was the outcome of an urgent desire to "make something," coupled with the real need for a versatile drilling machine for drills up to  $\frac{1}{4}$  in. It was almost entirely constructed from mild-steel bar and stock castings, the base being the only part for which a pattern was made. The hand work required gives excellent practice with the hacksaw and file. The whole of the machining was done on a 4 in. Drummond lathe.

The arms carrying the vice and table can be swivelled round to bring either under the chuck. One arm is arranged with a canting head enabling the vice or table (which are interchangeable) to be canted to 45 degrees for bevel drilling. The spindle sleeve runs on radial ball-races; also the thrust on the spindle is taken by a ball. The jockey pulley arrangement allows one belt to be used for all speeds and enables tension on the belt to be adjusted to take up any stretch. The drill is driven by a  $\frac{1}{4}$  h.p. 1,500 r.p.m. electric motor mounted on the bench at the rear of the machine. Spindle speeds range from 750 to 3,000 r.p.m., and the chuck takes from No. 80 to  $\frac{1}{4}$  in. A  $\frac{1}{4}$  in. hole has been drilled through  $\frac{1}{2}$  in. mild steel in 30 seconds.

The drawings were begun in early March, 1935, and the drill was exhibited the following September at THE MODEL ENGINEER Exhibition, where it gained V.H.C. and the "Forster" prize, showing that some little success had been achieved in its design and construction.

Now for the construction. Figs. 1 and 2 are the side and front elevations respectively of the complete machine. Fig. 3 onwards are details of each part and will be referred to as we proceed. The first job is the base Fig. 3 and the pillar Fig. 4. As mentioned before, the base is the only part for which a pattern is required. If any reader making this drill would like the loan of this pattern, no doubt the Editor would forward any letters addressed c/o THE MODEL ENGINEER Offices. First drill the holes in the three holding-down lugs  $\frac{1}{4}$  in. clearance. Now mount it on the faceplate and face the top side. See that the whole surface can be covered without the tool fouling



Side view showing table and vice.

the pillar boss before finally tightening up the holding-down bolts and clamps. Reverse and, with suitable packing interposed to clear the pillar boss, skim up the under side. It now only remains to bore the pillar-boss hole a tight fit on the pillar. If your lathe will swing  $13\frac{1}{2}$  in. diameter in the gap, this can be done on the faceplate; don't forget to balance the other side of the faceplate, or you will find the lathe trying to walk when you start up. On smaller lathes it will be necessary to bolt the base on an angle plate bolted to the saddle and bore out with a bar between centres. To ensure that the hole is square, bolt the angle plate on the saddle and then run it up to the faceplate and adjust for squareness. The operations required on the pillar, which is a piece of turned steel shafting, are chiefly hacksaw and file. The hole for the link-pin should be drilled with a letter C drill and reamed out a light drive fit for the  $\frac{1}{4}$  in. steel pin. This pin and the other two (one in the other end of the link and one connecting the lever to the thrust housing on the spindle), if correctly fitted, can be of  $\frac{1}{4}$  in. diameter steel with nicely rounded ends just proud each side, and will not need any further securing to stop them working out. They will look much neater than if they are retained with split pins each side.

The arms for the drilling spindle Fig. 5 are cut from 1 in. by  $1\frac{1}{2}$  in. flat mild steel. Two are required. First carefully set out and saw away all surplus material possible; a little care in setting

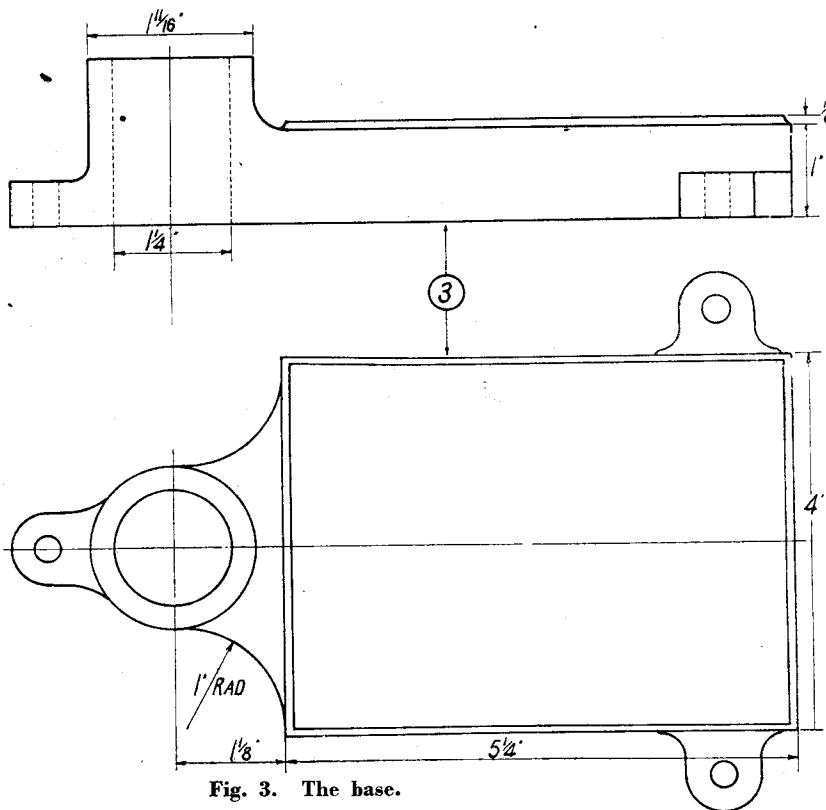


Fig. 3. The base.

out and hacksawing will save endless filing later. Dress up the external faces with a file and finish by drawfiling. Now clamp the two together and drill the  $\frac{3}{8}$  in. hole for the distance pillar; counterbore the hole on the bevelled side of each arm  $\frac{3}{8}$  in. diameter just deep enough to seat a  $\frac{3}{8}$  in. B.S.F. washer. Next bolt the two pieces back to

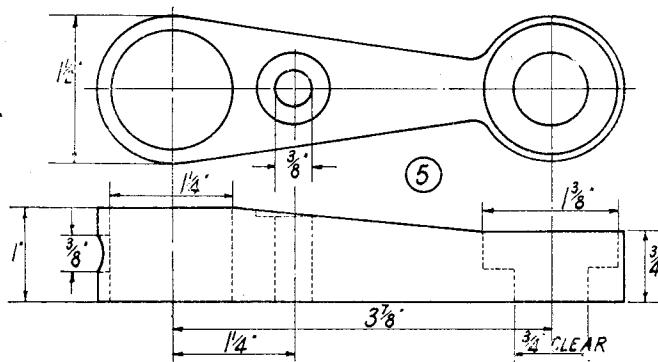


Fig. 5. Two views of the arm.

back, and, if your lathe will swing  $9\frac{1}{2}$  in. in the gap, mount on the faceplate and bore out the large end a close fit on the pillar. Now mount on the faceplate a short stub of  $1\frac{1}{4}$  in. diameter steel  $3\frac{7}{8}$  in. from the lathe to the centre of the stub. Put the arm with the already bored hole on this stub and adjust to bring the centre pop on the other end in alignment with the back centre; clamp firmly in position and bore right through  $\frac{3}{8}$  in. plus 0.005. Open this hole out to  $1\frac{3}{8}$  in. diameter  $\frac{3}{8}$  in.

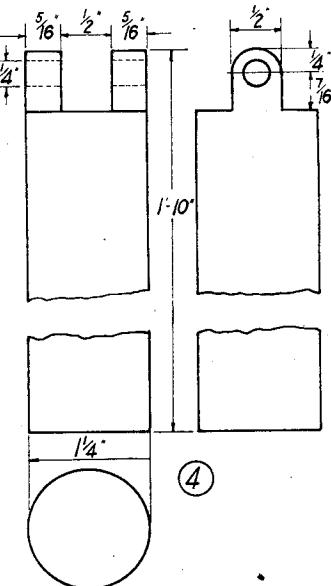
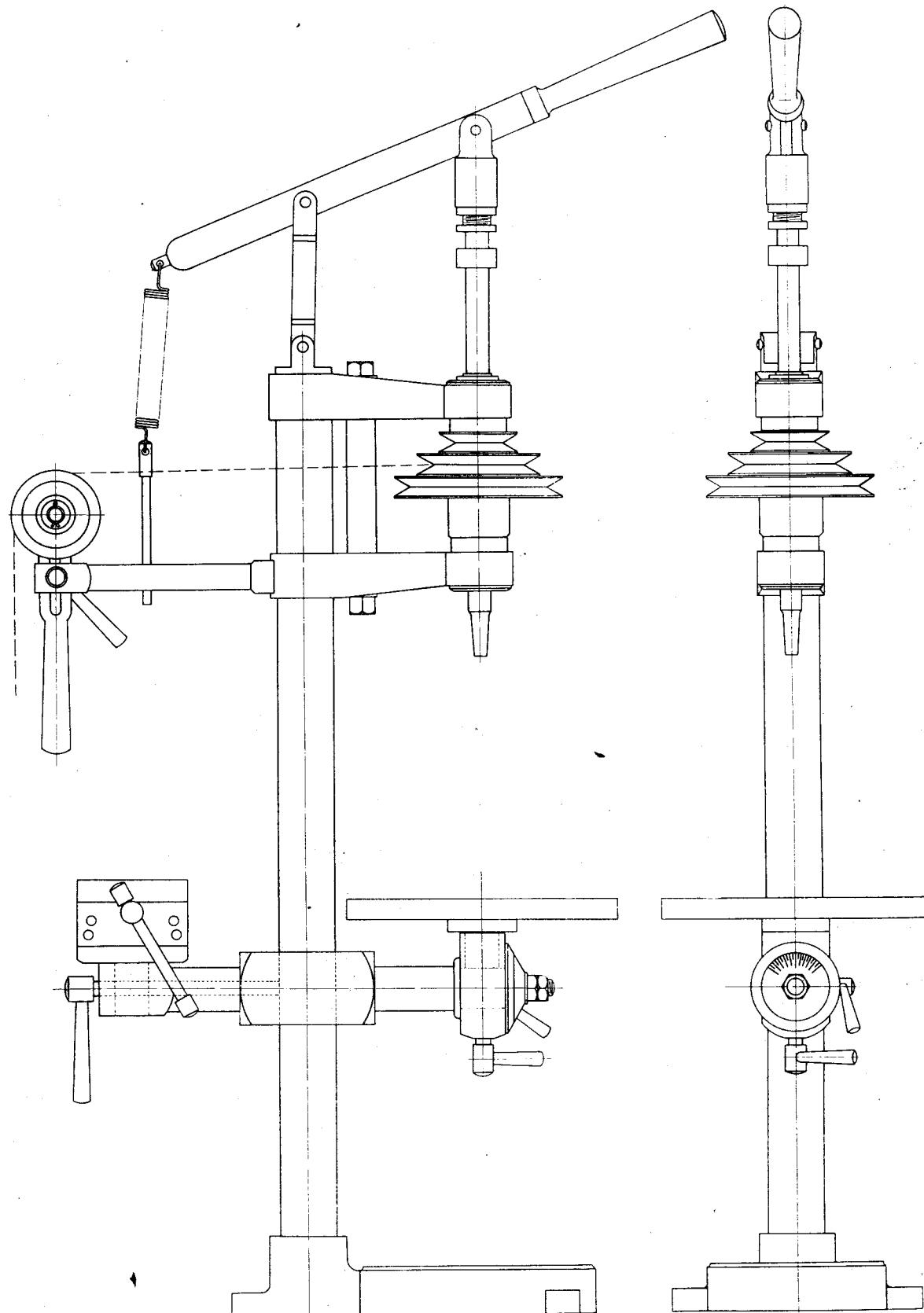


Fig. 4. The pillar.

deep; make it a push fit for the ball-race. A pair of these races will be required; they are extra light single-row type,  $1\frac{3}{8}$  in. o.d. by  $\frac{3}{8}$  in. bore by  $9/32$  in., and can be obtained from Messrs. L. B. McDonald, of 81 Bunhill Row, E.C.1. Catalogue No. S. 7/EE 5. Treat the second arm in the same manner. This method will ensure that the chuck spindle is truly parallel with the pillar. Only one arm (the bottom one) is required with the  $\frac{3}{8}$  in. clearance hole in the end breaking through into the pillar hole. This is for the fixed jockey pulley arm and also serves to fix the complete drilling head firmly on the pillar. The distance pillar Fig. 6 is a plain turning and screwing job and requires no comment.

The spindle sleeve Fig. 7 is turned out of  $13/16$  in. or  $\frac{7}{8}$  in. round bar. Drill through its axis and ream  $\frac{1}{2}$  in., then mount on a mandrel and turn externally between centres. Turn the ends down to  $\frac{5}{8}$  in., a tight fit in the ball-races. The threads for the locking rings are best screw-cut and finished with a die; they are  $\frac{3}{8}$  in. by 26 t.p.i. (brass gas thread). The slot for the spindle key can be end-milled or a row of holes drilled and finished with a file. The key is a piece of  $\frac{1}{8}$  in. mild steel case-hardened, a nice fit in the slot, projecting into the bore about  $7/64$  in. and flush with the outer diameter of sleeve. The locking collars Fig. 8 should be turned from 1 in. mild steel. Chuck a piece of bar, drill and tap  $\frac{3}{8}$  in. by 26, and part off; then mount on a true mandrel, turn and face to thickness. It is important that the threads are true with the outer faces and diameter. Four of these are required—one for the bottom ball-race, two for the top race and one



Figs. 1 and 2. Front and side elevations of the complete machine.

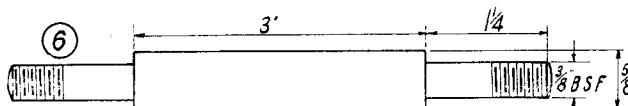


Fig. 6. Distance pillar.

for the ball-thrust adjuster. The slots for a C spanner can be made with a suitable slitting saw either in the lathe or by hand. A C spanner can be made to fit these from  $3/32$  in. steel plate with a piece of silver-steel brazed in for the key.

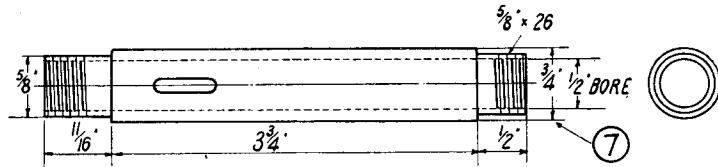


Fig. 7. Spindle sleeve.

The cast-iron pulley Fig. 9 is a plain turning and boring job. This is secured on the sleeve with a  $\frac{1}{4}$  in. B.S.F. grub-screw. The distance pieces Fig. 10 (two required—one above and one below pulley when assembled) are also straightforward turning jobs. These need not be set-screwed to the sleeve. The chuck spindle Fig. 11 comes next. This is best made from precision ground steel  $\frac{1}{2}$  in. diameter; the keyway can be milled or planed and

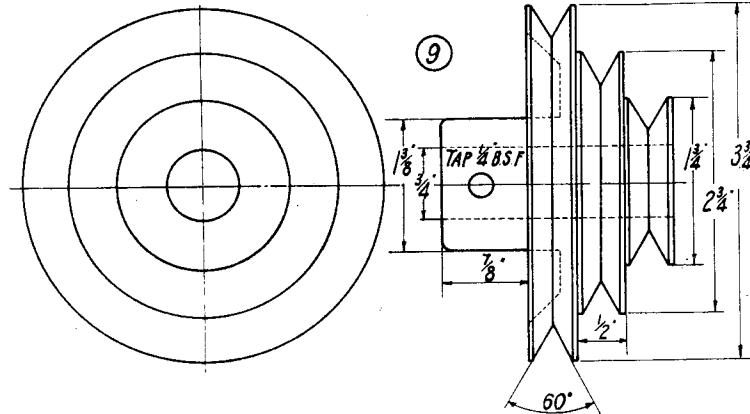


Fig. 9. Pulley.

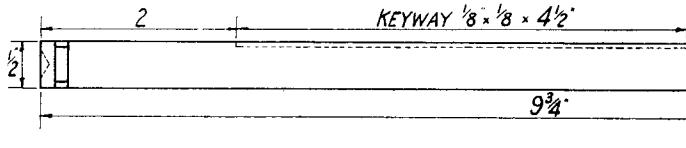


Fig. 11. The spindle.

the annular groove for the thrust-retaining keys turned with the end projecting sufficiently from the chuck jaws. The taper for the chuck on the opposite end is best turned with the spindle in a collet chuck. If this is not available, another way to do it is as follows:— If your self-centring chuck is reasonably true (I can hear someone say "Whose is?"), grip the top end in this and

support the other end with about  $1\frac{1}{2}$  in. projecting with a fixed steady. Now carefully turn the end down and adjust the taper to suit the chuck you are going to use. Spend a bit of time on this job; it will well repay in the end.

The drilling-head can now be assembled. Fit the spindle to the sleeve and insert the key; see that it does not bind in the spindle keyway when the sleeve is inserted into the pulley. The spindle should be a very close sliding fit in the sleeve. Place a distance-collar above and below the pulley, and, after inserting the ball-races into their

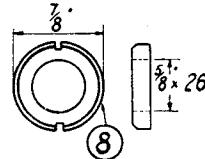


Fig. 8. Locking collars.

housings in the arms, assemble the arms on the sleeve, not forgetting the  $\frac{1}{8}$  in. distance pillar. The whole head should now slide on the main pillar, and if everything appears correct the nuts and locking rings can be tightened up. The ball-race covers, Fig. 11a, are turned out of brass blanks, the top one bored to clear the locking rings and the bottom one bored to clear the spindle only, as this fits below the lower locking ring, and a

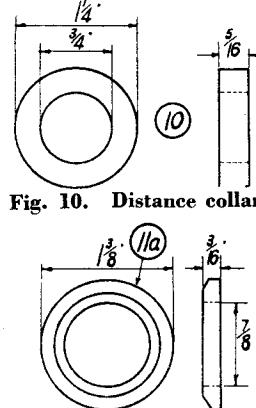


Fig. 10. Distance collars.

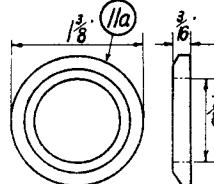


Fig. 11a. Bearing covers.

snap fit in the race housings. Pack the bearings with suitable grease before fitting the covers. If the head is completed to this stage and the bearing covers fitted, it will obviate any dirt and other foreign matter getting into the races during further operations and having to be washed out, which the manufacturers do not recommend.

*(To be continued)*

# \* Gauges and Gauging

In this instalment the author deals with the Zeiss Optimeter, and proceeds to discuss electrical methods of gauging

By R. Barnard Way

THERE are several points that have been raised in reference to this series of articles that we ought to consider. One in particular has been brought up by an old friend, who reminds me that block or slip gauges do not always remain in the accurate state in which their manufacturers deliver them. Well, of course, that is understood. It is the custom in most shops where they are used properly to have them checked up at regular intervals, basing this checking on their own standard bar, which in its turn ought to be submitted to the National Physical Laboratory at least once a year. Errors are of no account and can do no harm so long as they are known and allowed for in every measurement.

In every set, each block should be most accurately tested and its true dimensions recorded on a sheet pasted into the lid of the box in which they are kept. The size of each block is always taken from the list, and not from the dimension stamped upon it.

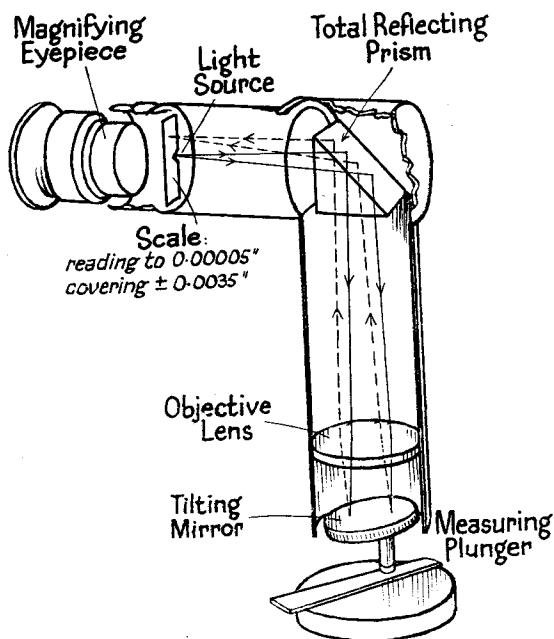
The temperature standardised for the final testing of standards in the control room is now, we believe, 68 degrees Fahrenheit, with an allowance of  $\pm 1\frac{1}{2}$  degrees.

In the last article we ended up with a few details about the interference fringes seen when using optical flats. It has been suggested that some explanation of this phenomenon might be of interest to the growing body of men who are daily employing this method of testing. We fear, however, that it is of too elaborate a nature for inclusion in these pages, and its interest too circumscribed. Just to whet the appetite of the few enquirers, we would say that the effects are primarily due to the fact that, on passing through a sheet of glass, some parts of the light ray are reflected from the outer surface, some from the inner surface, and those that pass right through and meet the metal specimen under test are totally reflected back again. It is the change of phase in the waves of the light on final emergence from the glass that produces the coloured circles or bands. With that, we must leave it for now.

For those who like an optical proposition, here is a diagrammatic representation to show the principle of the Zeiss Optimeter, an instrument of great precision, much in use in engineering shops where measurements of 0.00005 in. are commonplace. It is no exaggeration to use that word either, for the modern machine-tool builder needs it, so do the makers of aero engines and heavy oil engines. We have seen them in use in those places, as well as others.

Briefly, the device consists of a small mirror, pivoted on ball feet, so that the measuring plunger will deflect it if the specimen under examination varies from the standard dimension to which the machine has been set. The whole system reminds us irresistibly of the famous Kelvin galvanometer for detecting minute electric currents, in which the extremely small movements of a mirror are made visible by a ray of light thrown on to it, only to be reflected on to a distant screen.

The optimeter does this, through an optical system of lens and total reflecting prism, using a scale covering 0.0035 in., and divided into graduations equivalent to 0.00005 in. These are viewed by means of a magnifying eyepiece, which makes it a simple matter to estimate down to 0.00001 in.



Principles of working of the Zeiss Optimeter.

The source of light is a small electric lamp shining through a slit only 0.00001 in. in width, a remarkable enough thing in itself to produce, but, obviously, absolutely essential. You cannot hope to measure to such degrees of precision unless the indication on the scale is of so fine a nature that it might almost be said that it has no breadth at all.

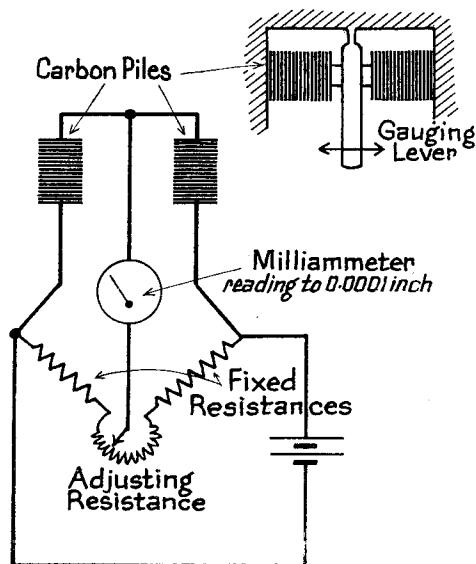
The optical principle, that the ray reflected from a mirror that has been moved through a certain angle is moved through double that angle, is

\* Continued from page 377, "M.E.", April 11, 1940.

usefully employed in this instrument, as we get a magnification of double the movement of the plunger for a start. This movement is magnified considerably on the scale by the optical arrangement, but, even so, such magnification would be futile unless the scale itself was engraved with extreme precision, which it is.

All these comparator instruments are provided with a trigger gear to lift the measuring plunger and lower it gently on to the specimen to be measured. The trigger is also used to ease the pressure of the contact spring—which is invariably provided to ensure an even measuring pressure—before the specimen is withdrawn.

The use of these instruments is increasing daily in workshops everywhere, and they are adapted for unskilled operation. It is a remarkable thing



Bridge circuit arrangement of an electrical gauging device.

to see the way in which decisions can be made in respect to ten thousandths by young women, with a precision that could not possibly be improved upon by the most expert hand with a vernier micrometer.

The swiftness with which an electric current will seize on the slightest opportunity to short-circuit its path gives us a practical method of getting a visible indication in a gauging device. Some time ago the writer watched a device of this sort at work accepting and rejecting piston rings. The rings had to fit into a hoop of such a diameter that the gaps were exactly closed, and if this condition was fulfilled a white light shone up. If it failed to go into the hoop, then the ring could go back to the shop to be dealt with, for the gap could still be slightly enlarged. A second hoop was provided for the rejects that failed to light up the white light, to judge the amount of the gap that still remained when the ring was closed, to the extent that its position at work in the cylinder

provided. If this gap was too great, a red light indicated that the ring was to go into the scrap-bin.

A machine for an exactly similar purpose, seen at work in a motor factory, was arranged to ring a bell whenever a ring failed to pass the test. It made no decision as to whether the rejected part was over or under size; it simply said, in effect, that the ring had to be thrown out, but whether these were re-examined subsequently we do not know.

Electricity can be called into gauging service in more exact ways than those of ringing bells or lighting lamps, however. The telegraph and radio engineers have devised instruments of extraordinary sensitivity, responsive to the tiniest movements of electric current or of iron armature. It is only to be expected, therefore, that these beautiful devices should lead to their exploitation elsewhere. The microphones used for sound recording are of various types, but one of the most remarkable is the ribbon type, where a thin ribbon of duralumin is vibrated by the sound waves in a strong magnetic field. Now the movement of a conductor in a magnetic field sets up minute currents of electricity in that conductor, and these can be taken and amplified to any extent, without distortion, by radio valves.

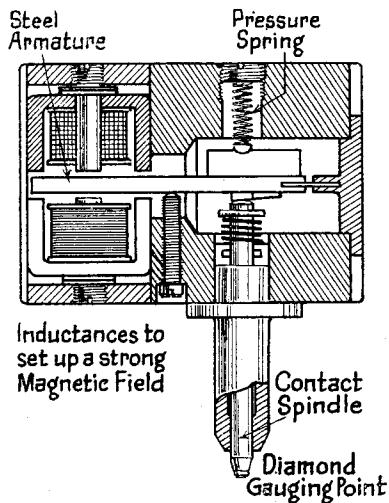
The gauge maker does not do it quite like that, but he does employ the principle of the moving iron in the magnetic field. In the beginning a scheme was employed in which the lever, moved by the specimen under examination, was held between two piles of carbon plates that formed part of a bridge circuit made up of fixed and variable resistances, of which the plates of carbon formed the principal units.

Movement of the gauging lever compressed one pile and eased off the pressure on the other, thus varying their resistance and consequently the current flow through them. A movement of the lever of 0.002 in. made a difference of 40 per cent. in the current flow, and this was easily recorded by a milliammeter that could be graduated in terms of the original movement of the gauging anvil. As a matter of fact, this device was originally put up to record deflections in a bridge under load. Here, for the benefit of those who can read electric circuit diagrams, is the arrangement.

The electrolimit gauging machine made by Taylor, Taylor and Hobson works on a principle that is somewhat similar. Instead of the carbon piles, there is a pair of inductance coils, with a gap between the cores in which a steel tongue armature moves. This tongue is the outer end of a lever, the fulcrum of which is a blade spring. The gauging spindle bears below this armature, and, owing to the relative placing of the fulcrum and the bearing plate, its movement is magnified three times in the inductance field.

The slightest movement of the armature in the field upsets the balance of flow of current in the circuit, which is on a similar plan to the Wheatstone bridge of the previous example. The extent

of this upset is reduced to terms of micro-ampères (millionths of an ampère), and recorded by a pointer moving across a scale, graduated into five bold divisions right or left of a zero mark. Adjustment is provided whereby this scale can be made to represent anything between 0.00025 in. and 0.004 in., according to the nature of the measurements to be made. In the first case, one division would thus represent 0.00005 in., with an



**Detail of the internal arrangement of the electric head of the Taylor Hobson Electrolimit gauge.**

adequate allowance for estimating fractions of this amount, for the five main divisions are further sub-divided.

Variation in the ratio of magnification is obtained by altering the gap between the inductance coils in which the armature moves. There are two sizes of instrument; the larger one has a scale  $4\frac{1}{2}$  in. across, and its lowest range provides magnification of 1,125 to 1. By adjusting the depth of the field, this can be increased to 18,000 to 1. With this latter ratio, one small graduation on the scale (measuring 0.7 in.) actually represents 0.0000042 in. We hope this multiplicity of noughts does not become too bewildering!

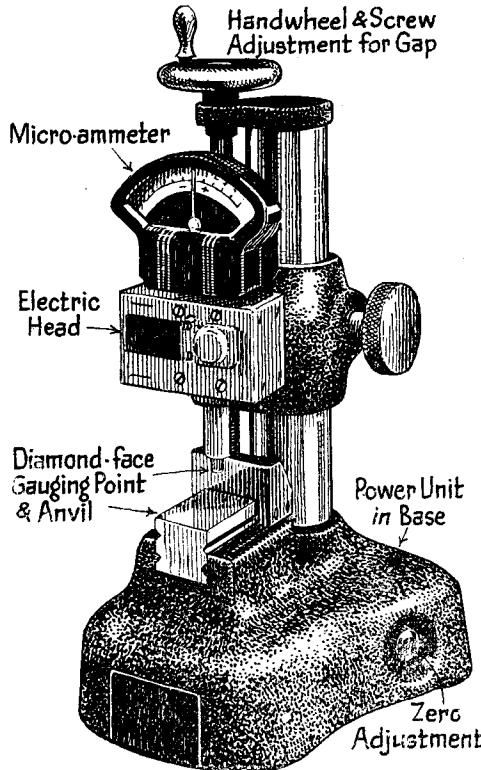
Setting the machine to zero, when it is to be employed for its recognised chief purpose—that of gauging a series of specimens for assembly—is done by wringing slip gauges of the size required to the anvil, and then bringing the gauging spindle into precise contact with them.

In order to reduce wear of the gauging point and the anvil to the minimum, the points are faced top and bottom with a diamond, having a true face of  $1/32$  in. diameter. The anvil is of hardened steel, ground and lapped to a fine finish and chromium plated. Slip gauges can be wrung on to its surface for the purpose of setting the point to the standard gauging gap required. Adjustment of the point is made by the screw handwheel and clamping screw, and final setting

can be made by a milled nut concealed behind the little door on the front of the electric head. The pointer can be brought to zero electrically by the zero control knob in the base.

The use of such a machine obviously calls for a very constant current flow, and so, as direct current is necessary, a transformer and rectifier unit is built into the base. This is supplied from the A.C. mains. Altogether a pretty instrument, and one that can be employed on a wide range of jobs.

This must complete our survey of the actual machines in the gauging service of the various departments. It is by no means complete, but it is, we hope, reasonably representative. We must now pass on to the final arbiters, the lordly measuring machines, such as the master micrometer that gives a definite decision to the one hundred thousandth part of an inch, and also the king of them all, the measuring device that gives you a



**The Taylor Hobson Electrolimit gauging machine.**

record true to the one millionth of an inch. These must, however, stand over until the next article, as there is a good deal to be said about them. It is necessary to see their work before we go into the subject of gauging screw threads, gear wheel teeth and the like.

*(To be continued)*

# Model Machine Shop Practice

A series dealing with modern machine shop practice and operations, more particularly as applied to model engineering

## Part VIII.—Lathe tools, their shaping and grinding

By Ernest F. Carter

MANY amateur lathe users find great difficulty in obtaining a smooth and perfect finish to their work, and in nearly every case the true reason for this defect is the incorrect manner in which the cutting tools used are shaped and ground to an edge.

In some instances, the reason for poor results can be traced to the use of inferior quality tool-steel, but it is true, too, that the experienced machinist can produce, from an old worn-out file, a lathe tool which will give results equal to one produced by a tool-maker or purchased ready-made.

Random grinding and regrinding of an expensive piece of special quality high-speed steel in an abortive effort to produce a perfect edge, will only waste the steel and give dissatisfaction in use. So we will consider the various types of tools, their uses, and the factors governing the shape to which

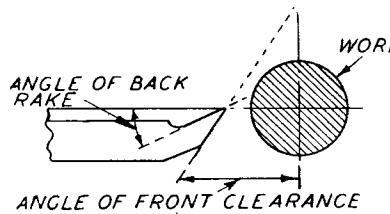


Fig. 1A. View from tailstock end.

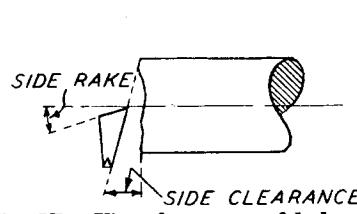


Fig. 1B. View from rear of lathe.

they should be ground; radically wrong curves and cutting angles are often used because it would seem that bad shapes are easier to grind than good ones.

### Some Definitions

As there are several terms which are constantly used in workshop parlance, and their meaning may not be clear to the reader, they will be explained with reference to Figs. 1 and 2.

"Side Clearance" is the angle to which the side of the tool is ground back to allow it to clear the side of the cut. "Side Rake" is the angle at which the top surface of the tool slopes away from the cutting edge *at the side*. "Back Rake" is the slope of the top surface of the tool *backwards* from the

cutting edge. "Front Clearance" is the angle formed between the front of the tool and a vertical line drawn through the lathe centre. The "Chip-curve" or "lip" (Fig. 2) is the hollow ground out immediately behind the cutting edge to allow the swarf or chips to clear the edge more easily.

Having now enlightened the readers on the terminology used in lathe tool description, let us see the principles underlying their correct formation and sharpening.

### Tool Shapes

One of the most important factors determining the shape to which a tool should be ground is the kind of material upon which it is to be used. Lead, for example, cuts much easier than steel, but the latter metal will not "draw" the cutting edge of

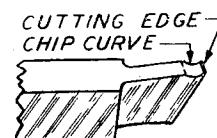


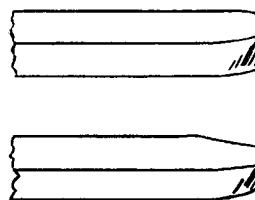
Fig. 2.

A parting tool, showing chip curve.

the tool into itself in the same way that softer metals have a tendency to do; and it is this "digging" characteristic which is the reason for a different setting and shape being required for each class of material if good work is to be produced.

Some metals, like bronze and brass, have a nasty tendency to "climb," or ride up on to the edge of the tool, particularly if the latter is really sharp; while other metals, like mild steel and wrought iron, form long tough shavings, and it is essential that these be allowed to escape freely from the cutting edge. High carbon steel and cast iron come away in small chips which do not tend to clog the tool.

Therefore, the angles of tools must vary with the metal being worked upon. Brass and bronze have



Figs 3A and 3B. Brass surfacing tools.

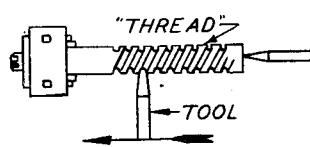


Fig. 4A. Effect of too high a traverse feed.

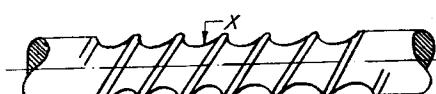


Fig. 4B. Enlarged portion of work fed too fast.

a leaning towards pushing the tool away if it has too much surface at the edge ; and this produces a wavy surface which is very difficult to eradicate. Moreover, if this ripple surface is formed just as the work is getting down to finished size, there may not be enough metal left to clear the waves and produce a smooth surface without making the job undersize.

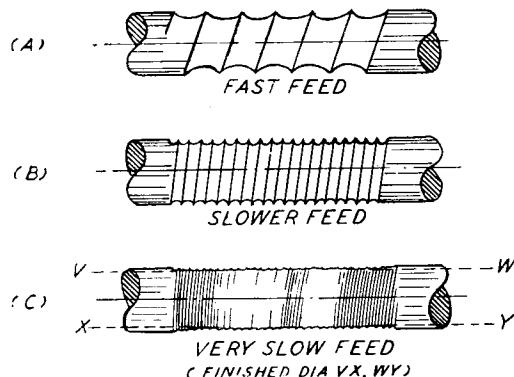


Fig. 5.

### Brass Turning

In working bronze and brass, the tool edge is kept at a minimum area so that only a small portion of work is in contact, thus the tool is very rigid, and does not tend to spring to the cut ; causing chatter. Such tools are shown in Figs. 3A and 3B, and

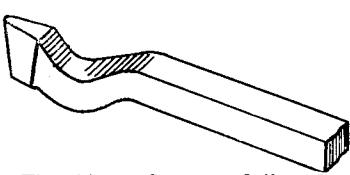


Fig. 6A. "Swan neck" tool.

Fig. 6B. Side view of "swan neck" tool.

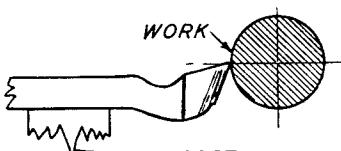


Fig. 7.

they are used for taking surfacing cuts between centres or across the face of work held in the chuck when a fine finish is required. ■

### Rate of Feed Important

When used for finishing, the tool should be maintained at a steady rate of progression so that a coarse "thread" is not cut on the job (Fig. 4). When a slow rate of feed is used with a round-nosed "brass" tool, a very fine finish can be obtained, as the circular indentations merge into each other as the feed speed decreases. Fig. 5 shows the gradual transition from the threaded effect to a perfect surface. Incidentally, these remarks apply equally to turning in all metals.

When turning brass no lubrication is necessary, and this rule also holds good for any machinery operations on that metal whether it be drilling, milling, tapping or reaming.

### Cast Iron

This class of metal is ever so much more brittle than others and thus the "break off" under the tool occurs much more easily, with the obvious effect that a greater cutting angle— $80^\circ$  is the best—can be used. The ideal clearance angle is  $10^\circ$  or thereabouts.

As regards the ideal cutting angle,  $80^\circ$  has been found to be the most durable, though it has been proved that the cutting angles which show the lowest value of cutting stress are not necessarily those which stand up to long usage without regrinding.

The tools used for taking straight cuts in iron and steel are known as "front" tools, and may be of the "swan-neck" variety (Fig. 6A), or of the type shown in Fig. 7. An outstanding advantage of the "swan-neck" tool is that it can be resharpened a number of times without altering its shape. Both types are largely used for taking surfacing cuts across work held in the chuck, or between centres.

Reverting to the turning of cast-iron, it is a good tip to bear in mind that the tool used for taking the finishing cut should have a good large cutting surface, and cut slightly at the back ; so that the pores of the work are closed, and the metal slightly burnished up, thus making for an easier polishing process if such is ultimately required. If too heavy a cut is taken, it will open the pores of the metal, spoiling the surface.

For high carbon steel and cast-iron the angle of top rake need not be so sharp, as these materials do not tend to clog the tool, though the resistance of the material is greater. The tool clearance can be kept down to give more support to the cutting edge if desired.

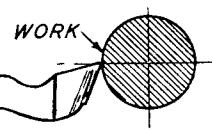
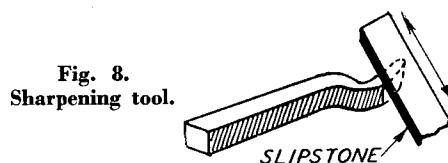


Fig. 7.

### Wrought Iron

This metal requires plenty of back and side rake to the tool (Fig. 1), and soda-water may be used as a lubricant if desired in preference to cutting dry; for it is all-important, in such tough metal, that the characteristically long turnings are turned away from the edge, or they will jam between the edge of the tool and the work. This will tear up the surface and ruin the finish. The tool should be set with its edge slightly above centre.

Fig. 8.  
Sharpening tool.

### Tool Sharpening

There are one or two points which should be borne in mind when grinding tools, and which are worthy of consideration in view of the bearing they have on the production of good tools, and thus good work

Lathe tools must never be ground at such speed that they are overheated in the process, for more tools are ruined by this maltreatment than by any

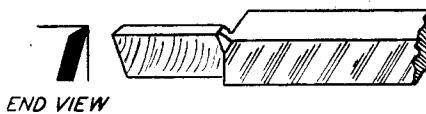


Fig. 9A. Right hand knife tool.

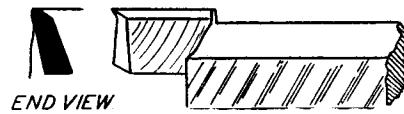


Fig. 9B. Left hand knife tool.

other. Tools should never be pressed too strongly against the stone, but *kept on the move*, thus reducing excessive heat at the point of contact, where the body of metal is small. The best grade of wheel to use is No. 26.

Owing to the excessive surface contact between flat-edged tools and the grinders, they are more liable to become overheated in the process. Tools with curved surfaces are not so prone to this trouble. Flat tools should, therefore, be ground wet, with emery wheels.

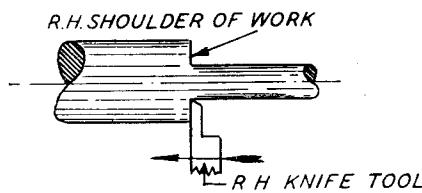


Fig. 10. Showing knife tool at work.

The final touches to tools with sharp lip edges and steep sides should always be done with a slip-stone; only the roughing-up to shape should be attempted on the wheel. (Fig. 8.)

### Hardening

There is no distinct advantage in "normalising" lathe tools by allowing them to cool off slowly after the hardening process, but a slight overheating at the actual cutting edge will often result in the latter improving with use. All turning tools should be hardened and tempered at the cutting edge to a straw colour.

It must be observed that the cutting edge of tools must be applied to the work on the line of centre, as shown in Figs. 1A and 1B, and to save packing between the top of the slide-rest and the underside of the tool to achieve this relationship,

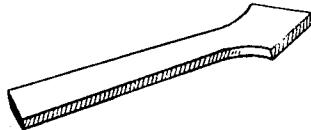


Fig. 13. Flat drill for slide rest.

it is best that care should be taken to select the right-sized tool stock to suit the slide-rest.

### "Knife" Tools

There are other types of tools which are used extensively for various turning processes. "Knife" tools, which are used for cutting into angles, and are named according to whether they are to cut the right-hand or left-hand side of a shoulder. They

are illustrated in Figs. 9A and 9B, while their use is shown in Fig. 10.

### Parting Tools

The parting-off tool (Fig. 11) is used for cutting off (or for squaring out corners of grooves, when the latter are not deeper than the length A-B (Fig. 12).

If parting tools are to be used on cast-iron or brass, the top surface should be left flat; but for wrought iron or steel the shape shown in Fig. 2 should be adopted. This has a "lip" or "chip-

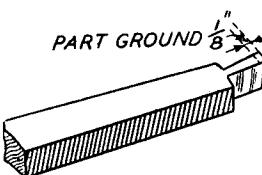


Fig. 11. Details of parting tool for cast iron and brass.

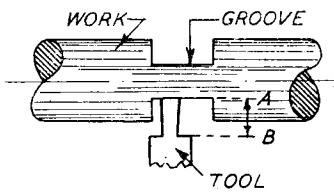


Fig. 12. Parting tool at work.

curve" behind the cutting edge, which allows clearance for swarf, as already explained.

The parting tool presents problems of its own. It must clear itself, even in deep cuts, and must have a decided back rake so it does not rub against the sides of the cut. This latter clearance must be provided on both sides.

### The Use of the "Lip"

The "lip" is not recommended for use on the softer metals, such as cause the tool to dig into the work. The "flat top" is the proper tool to use. This flat ground top need not extend more than  $\frac{1}{8}$  in. from the cutting edge, as back rake is needed to start the chips back from the cutting edge to prevent clogging.

Parting tools should always be set on the centre-line of the work, as this is the only place where the work is travelling at right-angles to the cutting edge.

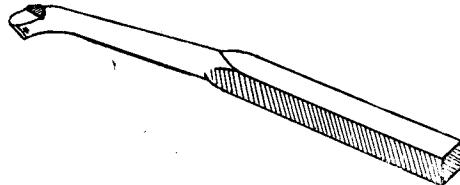


Fig. 14.

### Sound Advice

Any tool with a side-rake should *never* be used for cutting in a reverse direction to that for which it is ground, for by so doing it can only give a poor finish on the surface of the job, and a rapid dulling of the tool edge.

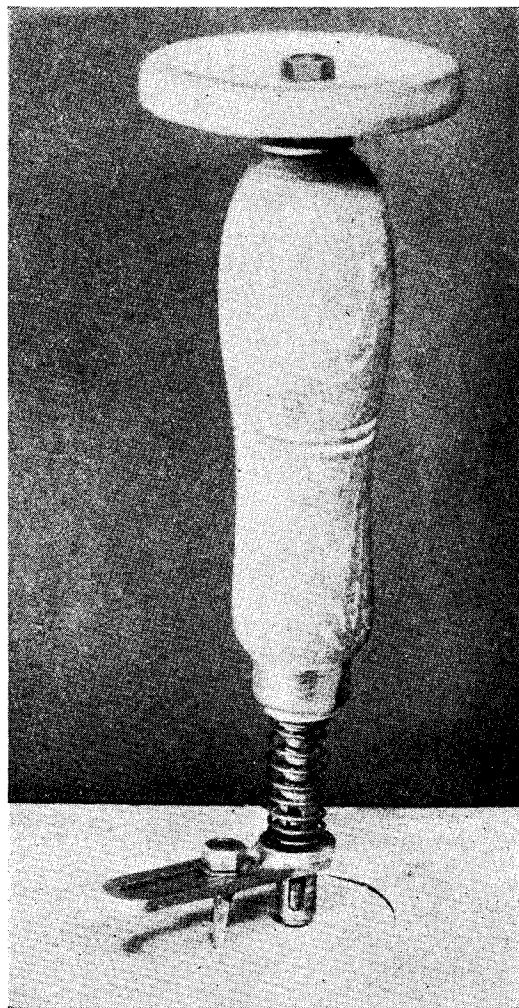
# An Adjustable Cutter

**A useful tool for cutting circles of wood, and leather and fibre washers**

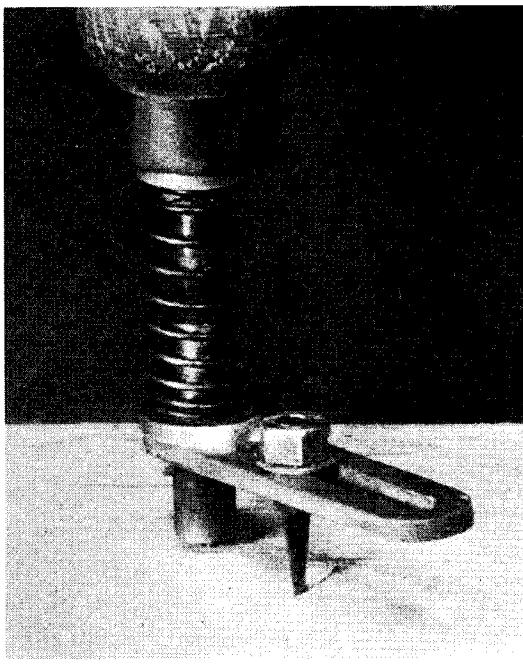
By W. Turner

A SHORT time ago a friend of mine, who is a keen aero modellist, asked me if I could suggest some means of cutting neat circles in balsa wood, for the purpose of lightening ribs, etc. As a result, I made an adjustable cutter, which I think may be of interest to other readers.

The sketch, along with the photos, explains the tool. It will be seen that the hardened point is



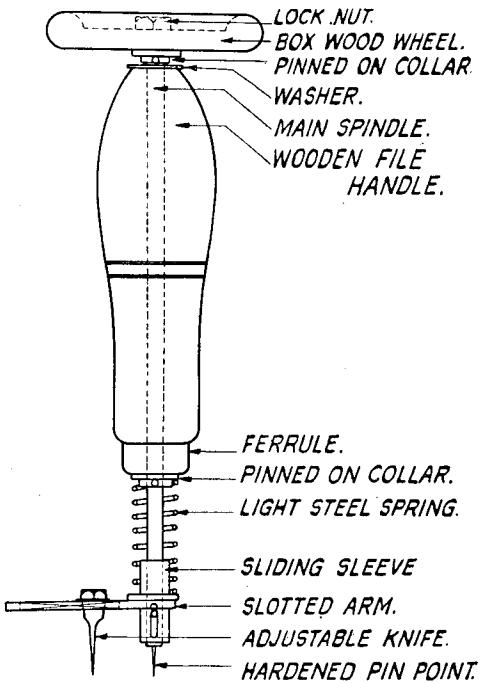
The cutter complete.



A close-up of the point and cutter.

pressed into the wood till it bears against the end of spindle, and held firmly in place with the handle. The cut is put on by the spring, resulting in a nice clean hole of size required.

The cutter may be used equally successfully for cutting leather and fibre washers, etc.



Details of the adjustable cutter.

# Queries and Replies

*Enquiries from readers, either on technical matters directly connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a coupon from the current issue, with a stamped addressed envelope, and addressed: "Queries and Service," THE MODEL ENGINEER, 60, Kingsway, London, W.C.2.*

*Querries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge. More involved technical queries, requiring special investigation or research, will be dealt with according to their merits, in respect of their general interest to readers, such as by a short explanatory article in an early issue. In some cases, the letters may be published, inviting the assistance of other readers.*

*In cases where the technical information required involves the services of a specialist, or outside consultant, a fee will be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.*

*Only one general subject can be dealt with in a single query; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.*

## 7,745.—Metal Questions—J.B.C. (Rugby)

**Q.**—I shall be most grateful for your advice on the two following points:—

(1) In turning gunmetal I find that the work gets burred, instead of coming up with clean edges. I have tried various speeds, but always with the same result. What is likely to be wrong?

(2) I am building a vertical drill, to be driven from my lathe countershaft, from a set of castings produced by a well-known firm.

The rotating shaft is  $\frac{1}{2}$ " in diameter, and the diameter of the casting is only about  $\frac{7}{8}$ ". Will silver-steel rotating in iron prove satisfactory?

If not, would it be feasible to use a soft metal liner, such as white metal, simply run hot into holes in the castings and drilled to size?

Alternatively, would phosphor-bronze bushes, say a full  $\frac{3}{8}$ " diameter, forced into the casting and then drilled and reamed, do the job? My own impression is that there is not sufficient metal in the casting to make this course a practicable one.

**A.**—(1) There is nothing particularly wrong in leaving a burr on G.M. or brass. The slightest touch with an emery slip or piece of paper will remove it, and leave a perfectly finished edge, which will not cut your fingers as will the burr.

(2) Silver-steel in cast-iron is quite all right for a small drilling machine. It is not worth while to line with white metal, and risky to try to bush  $3/16$ " thickness of metal.

## 7,732.—Re-Winding an Induction Motor—J.C.S. (Wallington)

**Q.**—Can you help me in winding the stator of a small motor? Although a model engineer, electricity is not my hobby. I have looked up back numbers for the last five years and have the book "Small Alternating Current Motors." My difficulty is that if I follow page 35 re increased turns, there will not be room enough in the slots. On page 50 it states, "Coils are polarised alternately north and south in sequence." Is this the same thing as shown in the "M.E." of June 8th last?

Particulars of the motor are:—Marked 205 volts, 0.76 amps., 50 cycles, 1,340 revs.; stator, 24 slots, each  $5/16$ "  $\times$   $\frac{1}{2}$ "; rotor, 26 bars,  $2\frac{3}{4}$ " dia.  $\times$   $2\frac{3}{4}$ " long; field coils, 125 turns, No. 26 wire; starting coils, 100 turns, dia. unknown, burnt out; three connections. The motor is totally enclosed, but I shall ventilate by drilling holes each end.

The information I need is the gauge and number of turns for 230 volts 50 cycles for starting and running coils; connections between coils and inlets; material for insulating slots and end of coils, and who are the makers of "Twinob" switches?

**A.**—Your drawing shows a 24 slot stator with a winding of the "concentric" type grouped to give four poles, which on a 50 cycle circuit will give a

running speed of 1,500 / 1,400 r.p.m. The disposition of the coils you have shown is quite correct, there being two coils per pole for the running winding and one coil per pole for the starting winding, the latter having its pole axis midway between that of the running winding. Assuming the length of the stator to be  $2\frac{3}{4}$ ", an output of  $\frac{1}{8}$  to  $1/6$  b.h.p. might be expected, and the windings recommended are:—

*Running Coils*—Eight in all, two per pole, each coil with 80 turns of No. 22 s.w.g. 6-mil. d.c.c. copper.

*Starting Coils*—Four in all, each with 165 turns of No. 28 s.w.g. 6-mil. d.c.c. copper.

All coils in each winding are to be connected in series with one another, each group interconnected so that current reverses in direction, so that the poles become alternately north and south round the circumference of the stator bore. On starting, the running and starting coils are put in parallel. As the speed picks up, the starting coils are cut out, leaving the running coils only in operation. Look up the articles "Building a  $\frac{1}{4}$  h.p. A.C. Induction Motor," in the "M.E." for July 7th and 14th, 1927, which contains full connection diagrams. 10-mil. Empire cloth and 10-mil. leatheroid should be used for slot insulation, one layer of each. "Twinob" starting switches are made by A. P. Lundberg & Co., Ltd.

## 7,742.—Brake Testing a 30 c.c. Engine—H.R.P. (Southampton)

**Q.**—Have you any designs or suggestions for making a fairly simple brake tester for a 30 c.c. engine, something simpler than the Froude type? I was wondering if something could be made from a small dynamo. There seems to be a great need for this kind of thing.

**A.**—It is quite practicable to use a small dynamo as a testing brake, and some information on this matter, with drawings and photographs, was given in the issues of the "M.E." dated July 25th and August 1st, 1935. If it is intended, actually, to measure horse-power it will be necessary to mount the dynamo up to swing bodily, and attach a torque arm, as described in this article. A motor car dynamo is suitable, but you will need a fairly large one to handle the power obtainable from a 30 c.c. engine. It should, however, be noted that these dynamos will handle a far greater load than is indicated by their normal wattage output, as they are run up to much higher r.p.m., and also develop higher voltage when the third brush is disconnected. The dynamo should be connected as an ordinary shunt machine, with a voltage regulating resistance in the field circuit, which is used for controlling the load and thus the engine speed; an accumulator or a fixed resistance can be connected across the main terminals.

# Practical Letters

## Model Loco. Boilers

DEAR SIR.—The article under the heading "Highland Chieftain," by Mr. Hunter, in the issue of THE MODEL ENGINEER dated April 4th is rendered particularly interesting by virtue of the remarks on model loco. boilers, more especially those referring to his unsatisfactory boiler fitted with a combustion chamber.

The remarks regarding priming and foaming bear upon a problem which has caused many headaches to those engaged upon research on full-size practice. Perhaps Mr. Hunter would be good enough to furnish more details of this boiler and of the conditions under which it was tested.

Foaming can be caused in a large number of different and conflicting ways; for example, grease and oils are supposed to be among those materials which cause this trouble, but one of the best additions which can be made to a boiler already in that condition is castor oil. (A very pertinent chapter on this subject is to be found in Matthews' "Boiler Feed Water Treatment.") In the case under discussion, it appears as though unsuitability of feed-water can be ruled out, and, in the absence of details of height of water in the boiler and actual hardness of the water, we are thrown on to the actual boiler design, although it is not certain that this is alone to blame. A water can be too soft, and pure distilled water sometimes foams considerably. Mr. Hunter tells us that the boiler without combustion chamber is quite satisfactory, and we can assume that the same water was used. This again points to boiler design. The only differences between the two boilers are the presence of combustion chamber and top-feed in one and not in the other; I think we might neglect the top-feed as responsible for the foaming, and consider the combustion chamber.

If Mr. Hunter is aware of the system of water heating and circulation in the national steam-wagon boiler, he will remember that this boiler was fitted with a number of conical thimbles projecting from the firebox into the firespace, and the behaviour of the water in these was very extraordinary; when the boiler was working, the thimble filled with water which was suddenly shot out again by the generated steam, whereupon it again filled with water, this process taking place in rapid sequence, at ordinary atmospheric pressure about three times per minute. This prompts me to enquire if the bottom of the cross-tubes in Mr. Hunter's boiler are so close to the boiler shell as to prevent the water from circulating freely in the normal way by convection currents, and so getting an effect similar to that in the national boiler. This could hardly fail to produce violent foaming and priming.

In my own experience I have a 2½ in. gauge "Fayette" type loco. with combustion chamber and six cross-tubes (also top-feed). This boiler is somewhat longer than Mr. Hunter's, and is completely satisfactory as far as bench tests go. Unfortunately, I have not yet got a track. A second case I know very well is a gauge "1" L.N.E.R. "Pacific" coal-fired boiler with combustion chamber with four cross-tubes; this is a good passenger-hauler and perfectly satisfactory.

The point I wish to make here is that we must not allow Mr. Hunter's one unsatisfactory boiler to put us off boilers of this type, as I am quite sure they are a step in the right direction, increasing end-to-end circulation of the water and giving more complete combustion of the fuel under very difficult conditions. I do not wish in any way to tread on Mr. Hunter's corns, but I should like to contribute something towards the solution of an awkward but most interesting problem. I am interested in boiler feed-water treatment by profession, as well as in small boilers, and hope that Mr. Hunter will not just "give it up," but will realise the very real advantages to be gained by the combustion chamber and will have another try.

The draught trouble Mr. Hunter mentions could hardly be laid at the door of the poor combustion chamber; after all, if the blast or blower produces a partial vacuum in the smokebox and the latter does not leak, air must be drawn through the fire, and the latter will burn; the area of the combustion chamber less the projected area of the cross-tubes must be greater than the sum of the areas of the fire tubes, and so could not constitute a serious obstruction.

If Mr. Hunter cares to get into direct contact with me, I shall be pleased to go further into the matter with him.

Burstwick.

Yours faithfully,

G.W.S.

## Propellers

DEAR SIR.—With reference to my article on "Propellers," published in THE MODEL ENGINEER on March 21st, I wish to draw attention to two errors which escaped my notice when correcting the proofs.

First: Page 302, second column, line 11, should be  
 "whose tangent =  $\frac{\text{Pitch}}{2 \pi r}$ ."

Second: Page 303, second column. The assumed revolutions should be 2,100 r.p.m. Then the theoretical pitch is equal to

$$\frac{7 \times 88 \times 12}{2,100} = 3.52 \text{ in.}$$

$$\text{Actual pitch} = (3.52 \times 1.15) = 4.05 \text{ in.}$$

Yours faithfully,  
 Cullercoats. J. HOUSTOUN.

## The Model "Uniflow" Engine

DEAR SIR.—Just a line to tell you how very much I was (and am) interested in Mr. Greenly's model two-cylinder vehicle, "Peach," valve-gear "Uniflow" engine, described and illustrated in THE MODEL ENGINEER, March 21st number. I served my apprenticeship in a steam-engine shop over 50 years ago, so, naturally, they have great interest for me. I should like to congratulate Mr. Greenly very highly.

Yours faithfully,  
 Leicester. S. W. WILKINSON.